October, 2009

Prediction of Failure mode of Full Scale Bridge Column using high performance mortar at the plastic hinge region

- Analysis Contest Rules -

1. Purpose

An analysis contest of bridge column is held in order to contribute to development of numerical prediction techniques for seismic response and failure behavior of reinforced concrete structures. A full scale rectangular bridge column using high performance mortar at the plastic hinge region is a target structure. Simulations are to be carried out before and after 3-dimensional shaking table test. Based on the comparison of the test and the analytical results, the best accuracy will be awarded.

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 Analysis: Predictions based on the anticipated earthquake loadings.
2. Post-Test Analysis: Predictions using the actual loadings. The same analytical models are to be used both for pre-test and post-test predictions.

2. Judge and acting committee

The contest is a part of the NIED E-Defense Bridge seismic test research team project, and will be carried out by working group (WG) of the team: Analysis Contest Working Group (WG) will do all the tasks including announcement, distribution of data, answering questions, judgment, and producing the experimental data for the high performance bridge column.

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. However, an individual or a team can participate in several categories described below. A member of the aforementioned WG 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. Category

The contest is categorized by the types of test methods. Winners will be selected for each of the following categories: (No restriction on analysis tools)

(Category1) Isolated bridge test analysis

Prediction of seismic response of bridge column using isolation devices for 30 and 40% input level.

(Category2) Failure mode predication analysis

Prediction of seismic response and failure mode of bridge column without isolation devices for 100% and second 125% input level.

(Category3) Category 1 and Category 2

Prediction of both Category 1 and 2

Each category will have one winner and a total of three winners will receive awards according to Section 10.

5. Schedule (The deadline is at 9:00am (JST). JST is GMT +9:00)

October 15, 2009	: Distribution of schedule of the contest, specification of structural components and basic material properties
December 21	: Start accepting of Pre-test Analysis, Distribution of acceleration for pre-test analysis and material properties (high performance mortar)
December 31	: Deadline of registration
February 17, 2010	: Submission of pre-test analysis results by participants
February 18	: Shaking-table test on bridge with isolation devices at E-Defense
February 26	: Shaking-table test on bridge without isolation devices at E-Defense
March 2	: Shaking-table test on bridge without isolation devices at E-Defense (with additional weight)
March 10	: Distribution of acceleration for post-test analysis, material properties
April 1	: Start accepting of Post-test Analysis
April 30	: Submission of post-test analysis results by participants
May 30	: Announcement of the winners

*Note: Analysis results shall be submitted via email.

6. Plan of test and analysis

Firstly, the shaking-table tests will be conducted with 10, 20, 30, 40% scales of seismic motion on the isolated bridge system. Subsequently, isolation devices are replaced to the normal pin-bearing. All the structural components except the isolation devices are used without replacement.

Secondary, the shaking-table tests will be conducted two times with 100% scale of seismic motion on the normal bridge system. After the test, additional weights are placed on the superstructure in order to compensate the self weight.

Lastly, the shaking-table tests will be conducted three times with 100% and 125% (two times) scale of seismic motion on the normal bridge system with additional weight.

Note that the above test plan will be subject to change depending on the damage of the test column.

In the pre-test analysis, anticipated earthquake loadings and the specified material data distributed by the committee should be used.

In the post-test analysis, measured accelerations at the shaking table and the actual material data distributed by the committee should be used.

7. Specimen data to be provided

The following data will be distributed via 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 loading conditions: weights of parts and non-structural components.

(3) Material properties: specification and stress-strain relationship, mix design of concrete

(4) Time-history of seismic motion: ideal acceleration for pre-test analysis, and measured acceleration for post-test analysis.

(5) Snapshots of the specimen.

* **Note:** All the detailed results will be available in two years, in the latest, after the shaking-table test at a website that can be reached from the website of NIED. Note that the detailed results cannot be distributed to anyone before the official distribution.

8. Analysis results to be submitted

8.1 Pre-test analysis

(1) State of plastic hinge region at the maximum response:

Steel yield configuration: yielding state and the location.

Concrete/mortar softening configuration: softening state and the location.

(2) Predicted responses in X, Y, Z direction at the top of the column (7500mm from the footing)

Time history of relative displacement and absolute acceleration.

Maximum absolute relative displacement and the occurrence time.

(3) Supplemental data:

Figures illustrating the deformation and plastification, the time histories of relative displacement at the top of the bridge column.

(4) 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 joint condition between concrete and steel and their location should be described. The input echo of the analysis program is preferred, while the geometry data such as nodal coordinates and node-element relations are not needed.

(5) Description of the analysis model:

Finite elements used in the model, constitutive models, method of time integration, modeling of geometrically-nonlinear and so on should be described.

(6) Description of computational environment, and model and method for analysis:

Name of program, type of availability of program (free, commercial, research purpose), name of computer, CPU time, etc. should be described.

8.2 Post-test analysis.

The items to be submitted for post- test analysis are same as for the pre-test analysis.

Make sure that the same data except the seismic motion and the material properties distributed by the committee should be used for post-test analysis.

Note that the submitted results will be rejected if they are not consistent with the experimental data.

General remarks

i) The forms for submittal will be distributed by the WG committee.

ii) The responses in X-, Y- and Z-directions should be presented.

iii) The maximum absolute values of relative displacement and absolute acceleration are evaluated at the center of the column section at the column top.

iv) The weight of each mass are given in the documents distributed.

v) The column strain due to dead load should be subtracted.

vi) The maximum responses are evaluated as the absolute values.

vii) Predictions shall be in SI units (mm, kN, sec, rad) and each number should have four significant figures. ex: 0.01234 rad, 0.1234 kN

9. Method of judgment.

The judgment is given by the WG committee based on the data submitted. The team/individual with maximum total point in the followings will be the winner for each category.

(1) State of plastic hinge region at the maximum response:

Steel yield configuration: yielding state and the location.

Concrete/mortar softening configuration: softening state and the location.

(2) Degree of accuracy on the time history responses:

Time history of relative displacement and absolute acceleration

Maximum absolute relative displacement and the occurrence time.

The judgment will be carried out completely anonymously. In each category, top three entries will be announced.

10. Awards

The three first-place award winners are entitled to be guest speakers and will be awarded at the Conference on E-Defense Bridge Test Project 2010. The name of the team/individual with three best results in each category will be announced.

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1) Test for analysis: Bridge component tests

2) Test set up: Figure 1

3) Specimen:

A bridge column using High Performance Fiber Reinforced Cement Composites (HPFRCC) at the hinge region, as a new technology for controlling earthquake damage, is a target structure.

(see PDF file)

4) Important Dates (deadlines 9:00am JST; JST is GMT +9:00)

Registration

Opens: October 15

Deadline: December 31

Pre-test Analysis

Opens: December 21

Deadline: February 17

Shaking table test

Bridge with isolation devices: February 18

Bridge without isolation devices: February 28

Bridge without isolation devices (additional weight): March 2

Post-test Analysis

Opens: March 10

Deadline: April 30

5) Registration form (see WORD file)

6) Outline of the contest (see PDF file)

Comments

An analysis contest of full scale bridge column using high performance mortar at the plastic hinge region is held as a part of the NIED E-Defense Bridge seismic test research team project.

The contest is categorized by the types of test methods, 1: Isolated bridge test analysis, 2: Failure mode predication analysis, 3: Both of 1 and 2. In each category, based on the comparison of the test and the analytical results, the best accuracy will be awarded.