2019 PEER Blind Prediction (BP) Contest

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2019 PEER BP Contest: Overview

- Four-column **rocking** podium structure excited by **200** artificial ground motions on a shaking table.
- **Objective:** Prediction of **maximum bi-directional** seismic response.
- The structure was designed by an **ETH Zurich team** led by Profs. **Michalis Vassiliou** & **Bozidar Stojadinovic**.

- The tests were conducted using the 6-dof shaking table located at the Earthquake and Large Structures (EQUALS) Laboratory of the University of Bristol.

- Tests were supervised by Profs. **George Mylonakis** & **Anastasios Sextos** under the SERA transnational access project "**3DROCK: Statistical Verification and Validation of 3D Seismic Rocking Motion Models**" [http://www.sera-eu.org/en/home/].
2019 PEER BP Contest: Evaluation

Empirical cumulative distribution function of 100 Mave values

Cumulative Probability: \( CDF(x) = \frac{\text{# of Mave} < x}{100} \)

- For each team:
  \( Err_{EC}, ERR_{CC} = \text{abs (max vertical distance between team prediction CDF & experimental data CDF)} \)
- \( ERR = ERR_{EC} + ERR_{CC} \) (EC: El Centro, CC: Chi Chi)
- Teams are ranked in order of increasing \( ERR \)

13 teams with contestants from 10 different countries
2019 PEER BP Contest: Winners
2nd Place
2nd Place
Discrete Element Modeling of a rocking podium structure subjected to biaxial shake-table test

PEER Blind Prediction Contest 2020

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Matthew DeJong Research Group - MDRG
Numerical method & main assumptions

- Distinct Element (DE) Method-based numerical model
- Rigid blocks connected by nonlinear springs with normal ($k_n$) and shear stiffnesses ($k_s$)
- Mohr-Coulomb criterion with no-tension (assumed $\mu = 0.2$)
No artificial (numerical) damping was introduced to the system

Only frictional dissipation was considered

This assumption also reduces the runtime of analysis, as damping generally decreases the time step
Modeling strategy

- Each structural component faithfully reproduced numerically
- Conical restraints and top/bottom slabs rigidly connected
Modeling strategy

- Each structural component faithfully reproduced numerically
- Conical restraints and top/bottom slabs rigidly connected
- System nonlinearity lumped into columns-to-restraints interface springs
Results and Conclusions

- Simplified modeling strategy enabled to obtain results in a reasonable timeframe
- Collapse mechanisms explicitly reproduced numerically

Empirical CDF - ChiChi

For details, see the related poster
1st Place

Pacific Earthquake Engineering Research Center
2019 BLIND PREDICTION COMPETITION
FIRST PLACE
University of Toronto
 Awarded January 16, 2020
1st Place
OVERVIEW OF FINITE ELEMENT MODELLING AND RESULTS

Myron Chiyun Zhong, PhD Candidate
Constantin Christopoulos, Professor
University of Toronto
Jan 16th, 2020
Finite Element Modelling

Model Overview

Test Specimen (PEER 2019)

3D Modelling - SolidWorks

FE Modelling - ABAQUS

FE Model Detail

Detailed Mesh Layout
Friction Coefficient: 0.3  Element Type: C3D20R
Inherent Damping Ratio: 0  Contact: Small-Sliding

Rocking Podium Model Overview

Rocking Column

Push-Pull Analysis

$F_{ws}$: weight of superstructure

rocking initiation point

overturning point $\approx 171$ mm

2015 N (max)

1806 N
Overview of Analysis Results

Sensitivity Analysis
Perform Sensitivity Analysis to investigate:
- Pushover responses
- Dynamic responses under a few selected ground motions

Varying Parameters:
- element type;
- analysis step size;
- mesh size;
- friction coefficient;
- contact algorithm;
- relative stiffness between contact regions

Pushover Responses:
Contact Algorithm

Dynamic Responses:

Mave Parameter – Different Mesh Size

Mave Parameter – Different Step Size

Mave Parameter – Different Friction Coefficient

Mave Parameter – Different Elastic Modulus

Results Summary of 200 GMs
Analysis Results of 200 GMs:

Sample Rocking Responses:
Small Amplitude Rocking Response (GM – EC80)
Medium Amplitude Rocking Response (GM – CC45)
Near-Collapse Rocking Response (GM – CC45)
Sample Analysis Results - Animation

Ground Motion CC61 – Analysis Results Animation

For details, see the related poster
Next: Poster Session & Reception
University Club, California Memorial Stadium