JANUARY 18-19, BERKELEY, CA
PACIFIC EARTHQUAKE ENGINEERING RESEARCH CENTER
2018 Annual Meeting
UC BERKELEY • CALTECH • OSU • STANFORD • UC DAVIS • UC IRVINE • UC LOS ANGELES • UC SAN DIEGO • UNR • USC • U WASHINGTON

Closure, Wrap Up & 2017 PEER Blind Prediction Contest

Khalid M. Mosalam
PEER Director, Taisei Prof. of Civil Eng.

PEER

PEER at 21: The Practice of Performance-Based Engineering for Natural Hazards

2017 PEER Blind Prediction Contest

- ✓ Collaborative effort between UCSD & UCB
- ✓ **Team**: A. Nema, J. Restrepo, UCSD; Y. Wu, S. Günay, K. Mosalam, UCB
- ✓ Bridge bent with 2 columns
- ✓ Self-centering with PT bars
- ✓ Energy dissipation by unbonded longitudinal rebar yielding
- ✓ Tested at the UC Berkeley PEER shaking table in Sept. 2017

PEER

The Contest

Resilient here means self-centering

Event Name	Station Name	NGA #	Rotation	Unscaled PGA [g]	Scale Factor	Target Drift [%]
Random Noise	-	-	-	2.5% RMS		0.1
Landers, 1992	**Lucerne**	**879**	**10**	**0.72**	**0.9**	**0.6**
Random Noise	-	-	-	2.5% RMS		0.1
Landers, 1992	**Lucerne**	**879**	**10**	**0.72**	**0.9**	**0.6**
Random Noise	-	-	-	2.5% RMS		0.1
Tabas, 1978	**Tabas**	**143**	**30**	**0.85**	**-0.9**	**1.8**
Random Noise	-	-	-	2.5% RMS		0.1
Kocaeli, 1999	**Yarimca**	**1176**	**62**	**0.3**	**1**	**0.6**
Random Noise	-	-	-	2.5% RMS		0.1
Northridge, 1994	**Rinaldi**	**1063**	**-30**	**0.85**	**0.81**	**4**
Random Noise	-	-	-	2.5% RMS		0.1
Duzce, 1999	**Duzce**	**1605**	**88**	**0.51**	**1**	**1.8**
Random Noise	-	-	-	2.5% RMS		0.1
Northridge, 1994	**Newhall**	**1044**	**58**	**0.72**	**-1.2**	**4**
Random Noise	-	-	-	2.5% RMS		0.1
Kobe, 1995	**Takatori**	**1120**	**-40**	**0.76**	**-0.8**	**5**
Random Noise	-	-	-	2.5% RMS		0.1
Kobe, 1995	**Takatori**	**1120**	**-40**	**0.76**	**0.9**	**7**
Random Noise	-	-	-	2.5% RMS		0.1
Tabas, 1978	**Tabas**	**143**	**30**	**0.85**	**-0.9**	**-**
Random Noise	-	-	-	2.5% RMS		0.1
Northridge, 1994	**Rinaldi**	**1063**	**-30**	**0.85**	**0.81**	**-**
Random Noise	-	-	-	2.5% RMS		0.1
Kobe, 1995	**Takatori**	**1120**	**-40**	**0.76**	**-0.8**	**-**
Random Noise	-	-	-	2.5% RMS		0.1

- **10** teams in "**Research & Academic Category**"
- **9** teams in "**Practicing Engineers Category**"

The Contest

Provided Information Included:

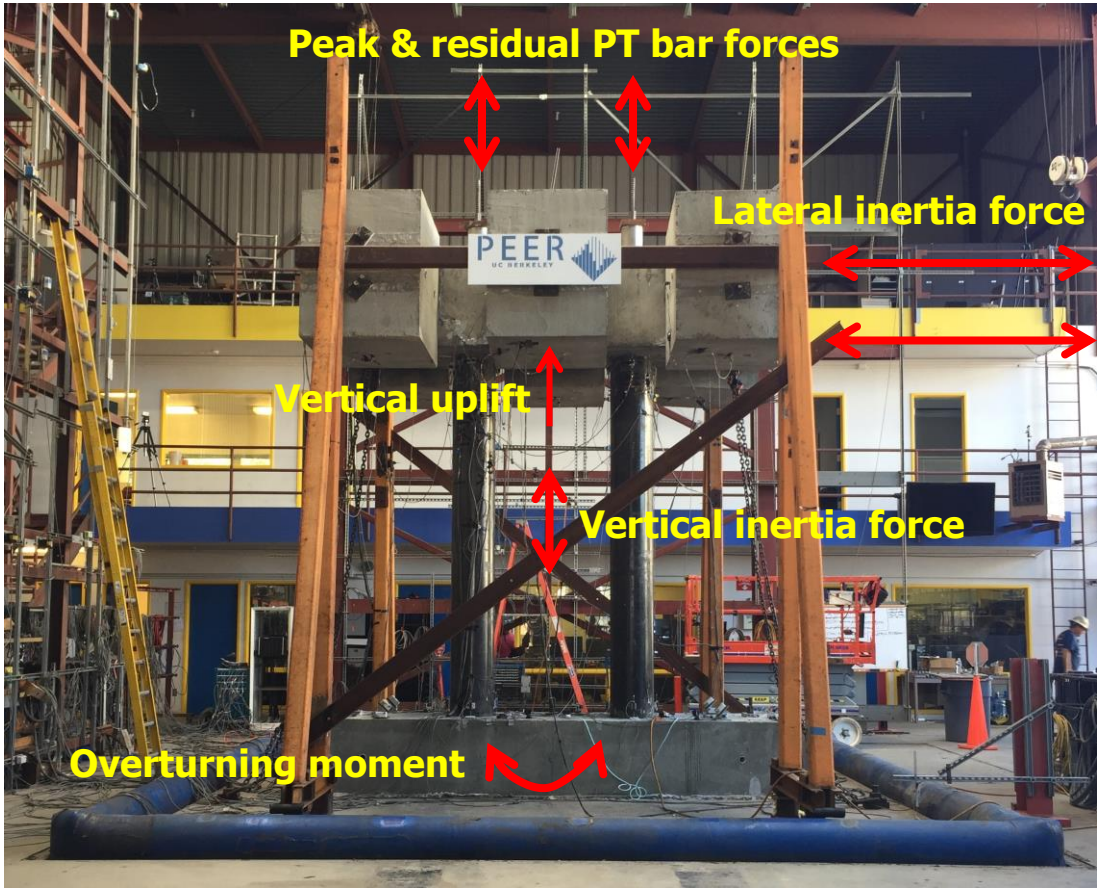
- ❑ Structural drawings
- ❑ Tested material properties for steel bars, concrete, prestressing bars, steel shell & grout
- ❑ Construction sequence including photographs
- ❑ Accelerations measured on the table for each test
- ❑ Properties of the weight blocks

Category	1	2	3	4	5	6	7	8	9	10
Engineers	**397**	371	290	245	197	197	122	109	92	-
Researchers	**382**	304	228	223	214	201	194	103	99	54

Scoring was based on:

- ❑ 13 quantities predicted for each of the 9 ground motions (Total: 13×9 = 117 quantities)
- ❑ For each quantity, team with min. error → **8** points, 2nd → **5** points, 3rd → **3** points, 4th → **1** point, and others → **zero**.
- ❑ Total score of each team is sum of all points from the 117 quantities. Two teams of highest score in the practicing engineers & research communities are the winners.

Predicted Quantities



Winning Team: **Research & Academic Category**

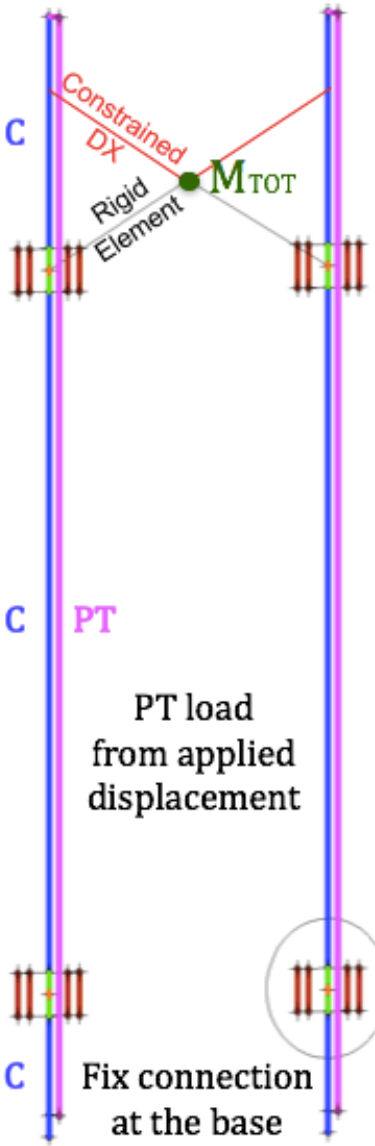
University of Bergamo, ITALY

Michele Egidio
BRESSANELLI
Post-graduate researcher

Marco
BOSIO
Post-graduate student

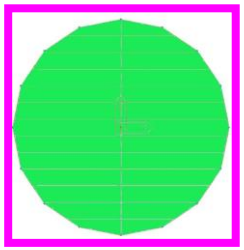
Andrea
BELLERI, PhD

Assistant professor, Principal Investigator

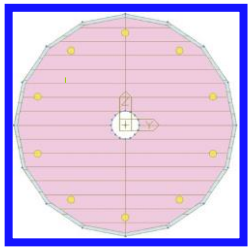


Fiber element Cross-sections

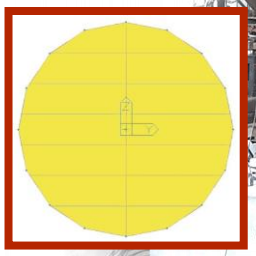
PT



Column C



Rebar



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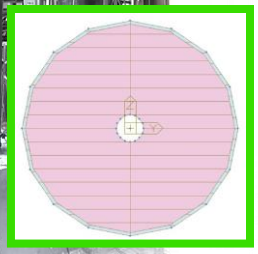
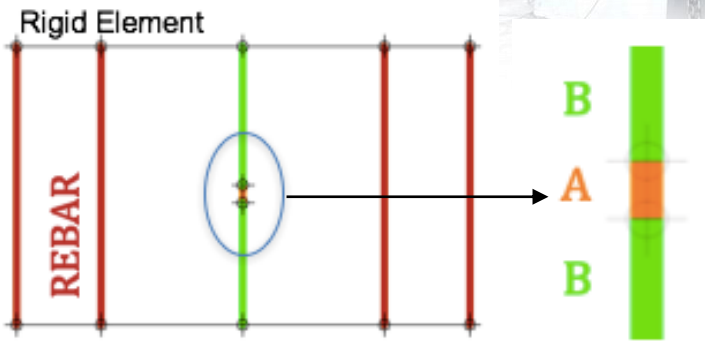
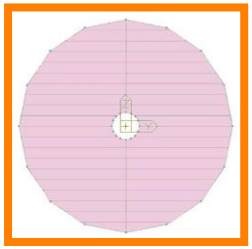




Column A



IDEAL IDEA…

create a refined analysis in Abaqus to validate
a simplified beam model (MidasGEN) to be used in the contest.

Although, due to time constraints…

the simplified models have been directly validated by means of pushover analyses

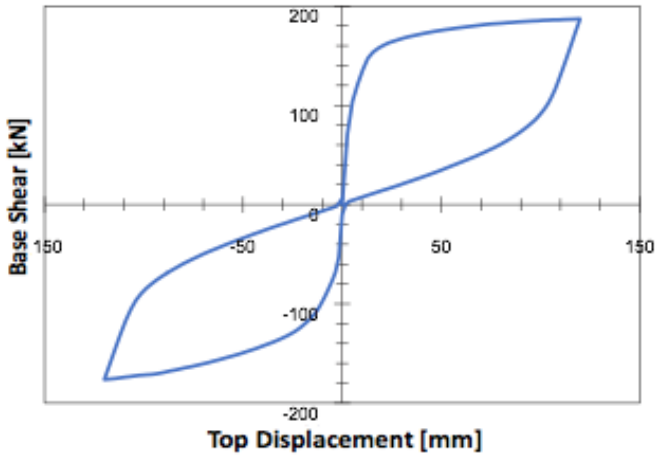
MidasGEN, 2017

Although, due to convergence issues…

the model has been further simplified in the time-history analyses

Pushover

1st Method: Pushover Analysis		
Geometric Nonlinearity Type: Large Displacements		
Maximum step size [s]		1.00E-05
Maximum Iteration		5
Convergence criteria	Displacement Norm	1.00E-06
	Force Norm	1.00E-06
	Energy Norm	1.00E-07
Runge Kutta Method	Fehlberg Method	
	Tollerance	1.00E-07



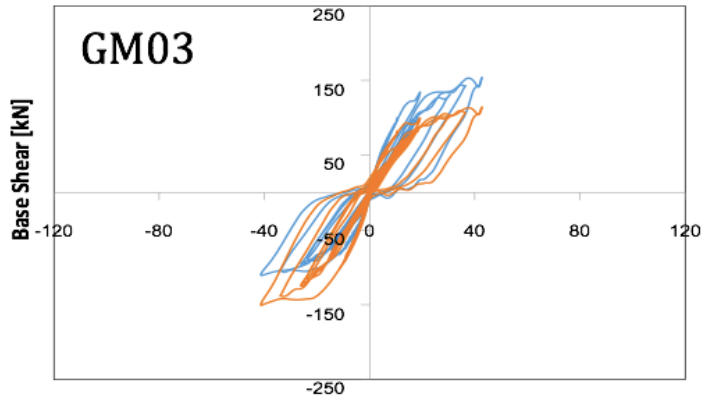
Time history

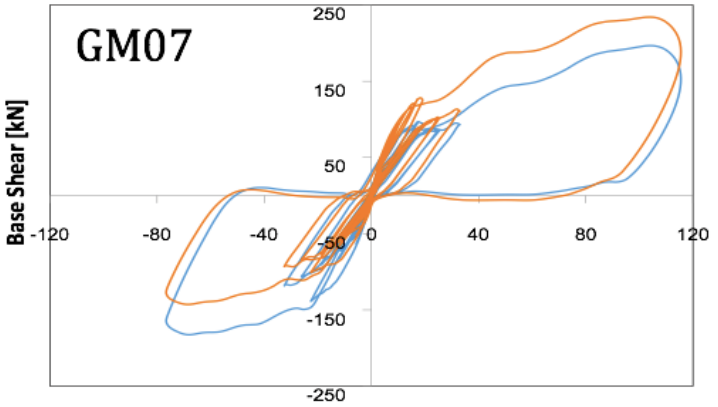
2nd Method: Time History Analysis		
Geometric Nonlinearity Type: Large Displacements		
Maximum Number of Substeps		2
Maximum Iteration		10
Convergence criteria	Displacement Norm	1.00E-05
	Force Norm	1.00E-05
	Energy Norm	1.00E-05
Runge Kutta Method	Fehlberg Method	
	Tollerance	1.00E-08
Damping Method: Mass e Stiffness Proportional		
Damping Type	Mode 1	Mode 2
Period [s]	0.1	1
Damping Ratio	3%	3%
Newmark Method	Gamma	0.5
	Beta	0.25

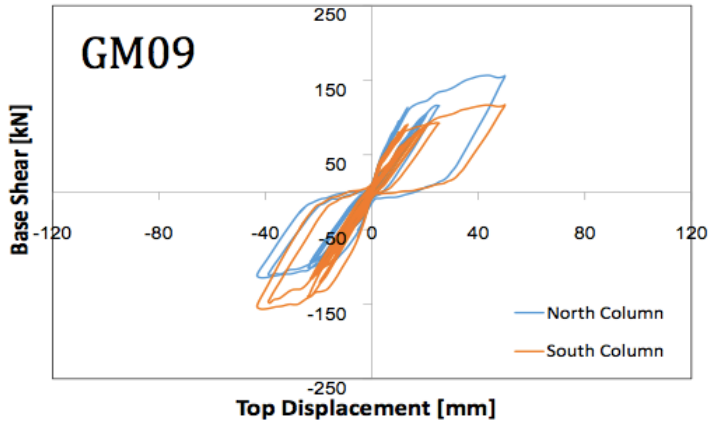
DAMPING

Mass + Tangent-stiffness

Rayleigh damping







Winning Team: **Practicing Engineers Category**

NYA – SAN FRANCISCO TEAM

Grigorios Antonellis, PhD, PE, Sr. Analyst

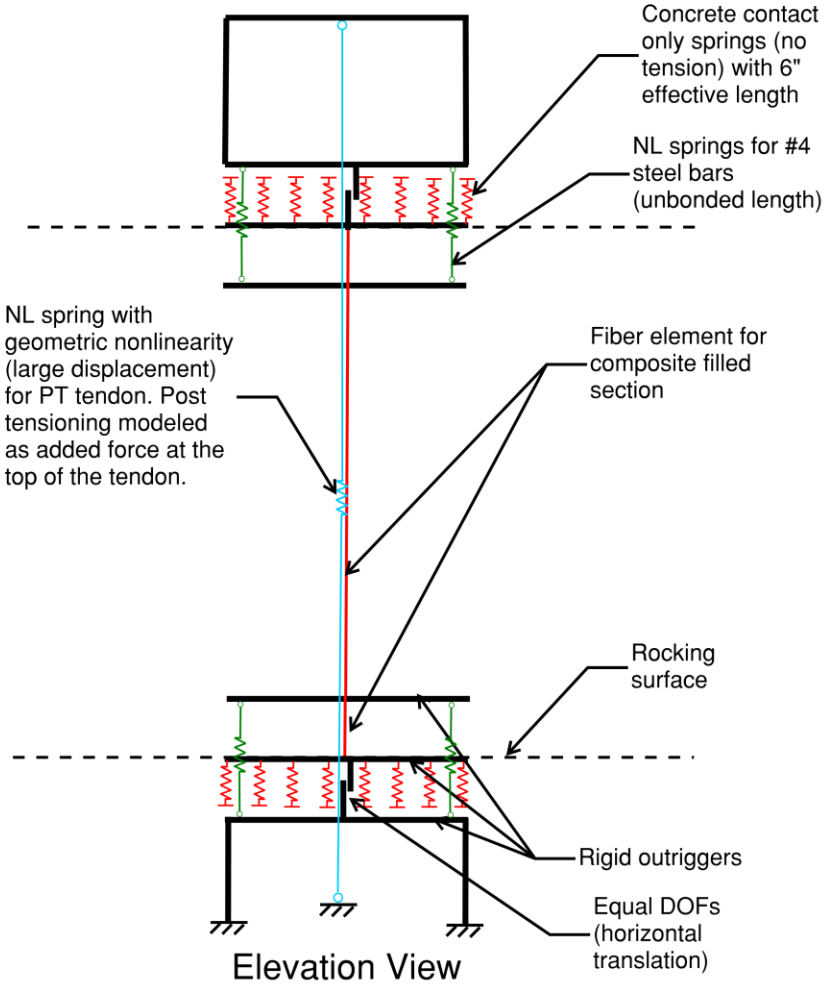
Andrew Ma, SE, Sr. Project Engineer

Anthony Giammona, SE, Vice President

- Two <u>independent</u> internal teams (LA vs SF office)
- Limited amount of man hours per team (~ 70 billable hours)
- ETABS 2016 Ultimate used intentionally to evaluate capabilities of common design software

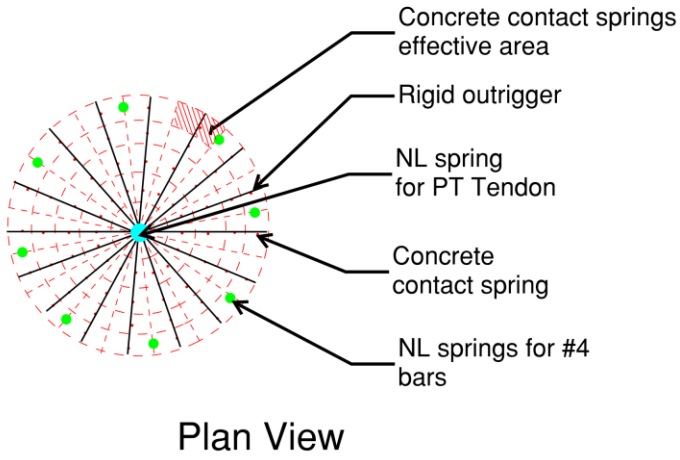
NABIH YOUSSEF ASSOCIATES STRUCTURAL ENGINEERS

ETABS 2016 Ultimate Model



Additional Modeling Assumptions

- Cap and foundation beams modeled as rigid elements.
- Point masses at selected joints along cap beam (translational and rotatory).
- Post tensioning modeled as external force at top of tendons.
- Kinematic steel hardening for #4 rebar and PT tendons.
- Confined concrete stress-strain per Mander.
- All joints restrained for out of plane motion.
- 0.2% modal damping at 0.1s and 1s.
- HHT integration scheme with a=-0.10
- Model T1=0.215 s.



Analysis Results

Quantity	*GM1*	*GM2*	*GM3*	*GM4*	*GM5*	*GM6*	*GM7*	*GM8*	*GM9*
Max DR (%)	0.41	0.35	1.29	0.39	2.29	1.46	3.30	2.24	4.10
Residual DR (%)	0.01	0.01	0.01	0.00	0.03	0.02	0.02	0.01	0.09
V_b/W	0.49	0.47	0.71	0.48	0.75	0.62	0.78	0.72	0.80
Max PT force (kip)	104	104	129	103	156	132	182	152	199
Residual PT force (kip)	96	96	96	96	96	96	97	97	97

Summary and conclusions

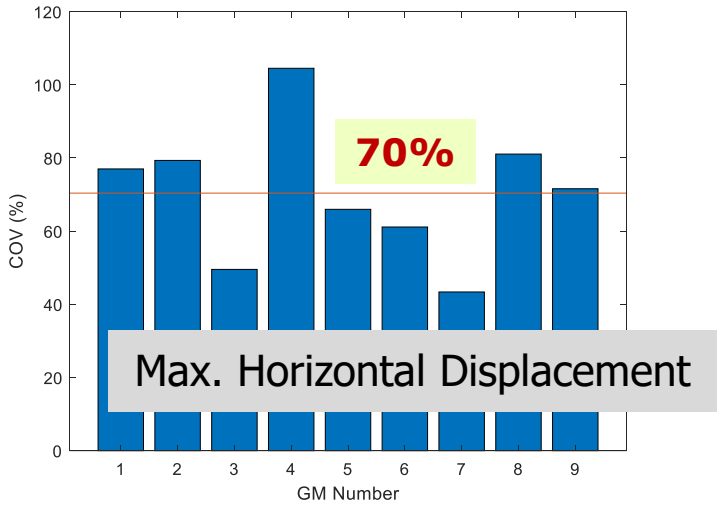
- Commercial software capabilities have been improving over the past few years. ETABS 2016 Ultimate was successfully used in this study.
- Use of NL springs (Links) is preferred instead of NL truss elements and PMM hinges, where possible.
- Sensitivity studies can be used to fine-tune the modeling:
  - Kinematic vs isotropic hardening vs Steel02 (OpenSees)
  - Discretization and effective length of concrete NL springs

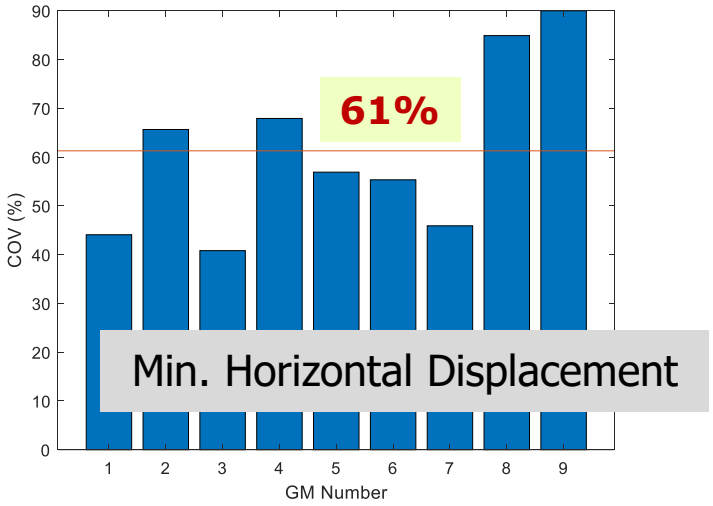
Both NYA teams used ETABS 2016 Ultimate and similar modeling strategies. SF team underestimated (and LA team overestimated) displacement related results. Force / acceleration related results were generally very similar for both teams.

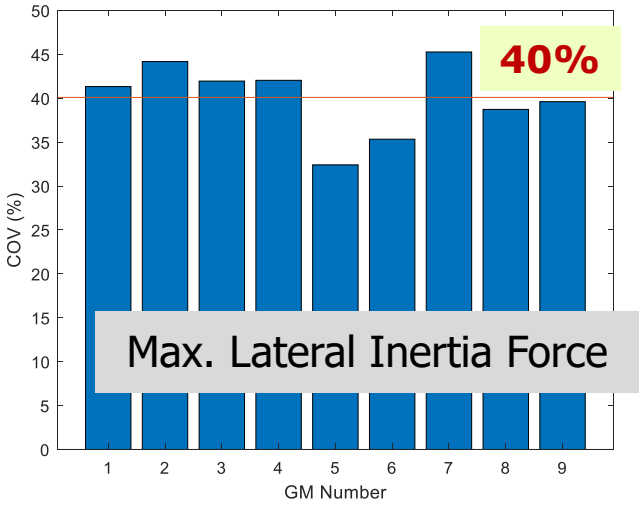
Acknowledgments

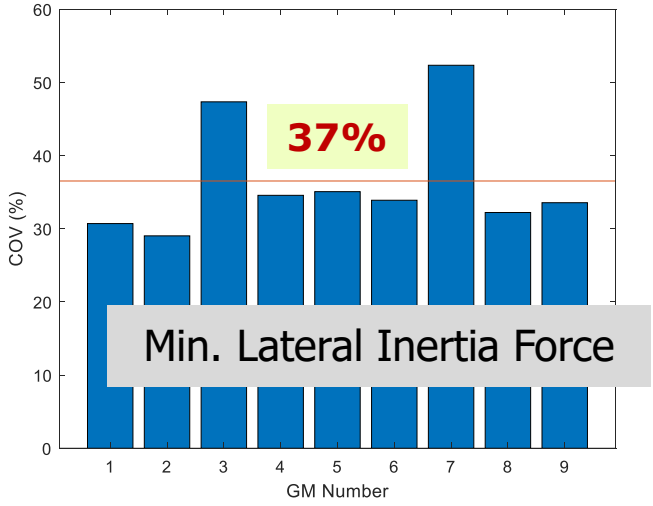
- Researchers and everyone at PEER who helped organize this contest
- NYA management for encouraging and supporting participation

Sample Results









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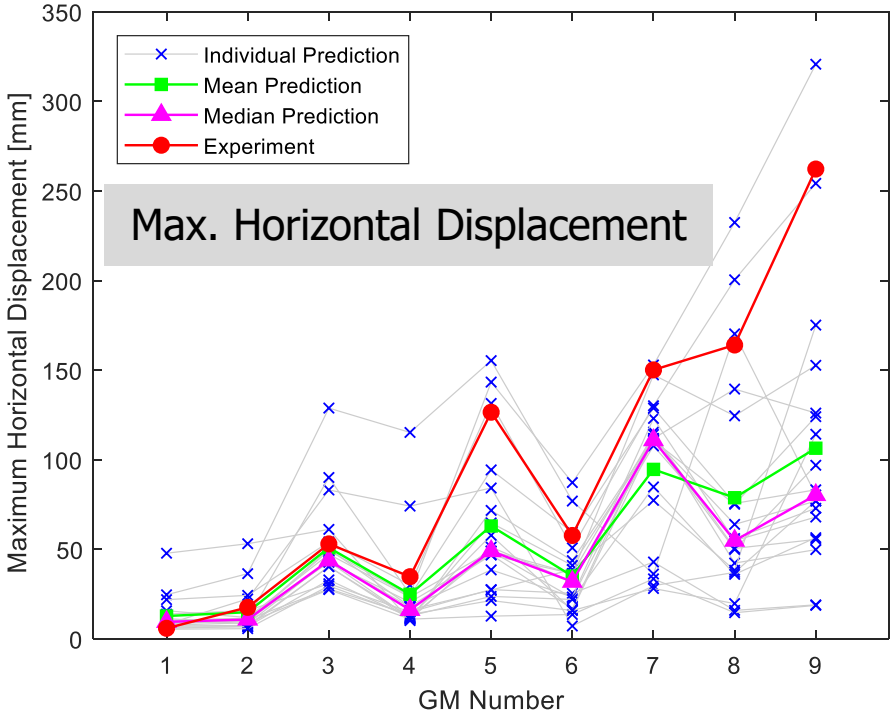
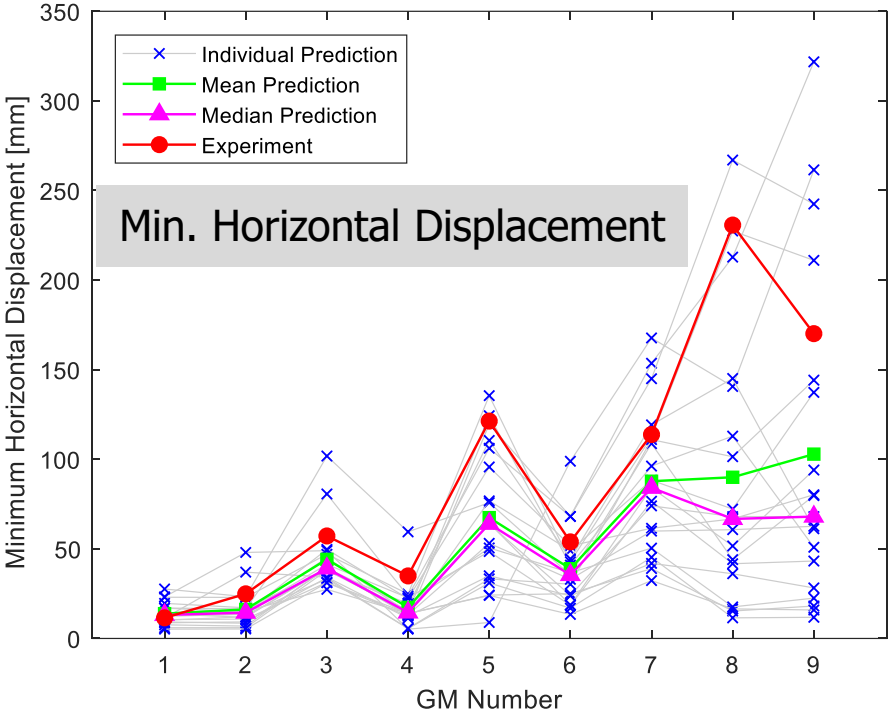
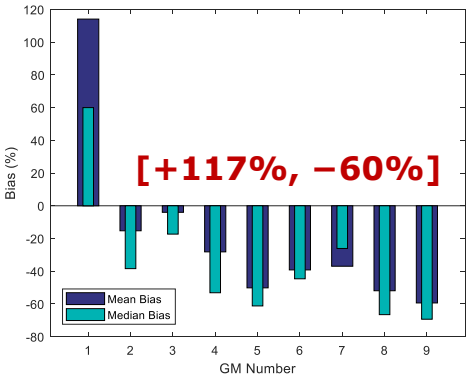
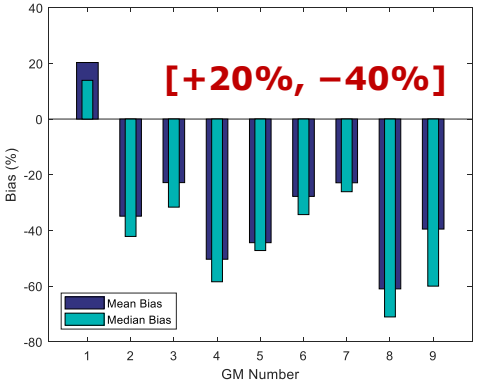
Sample Results







$$Bias = \frac{Predicted - Measured}{Measured}$$



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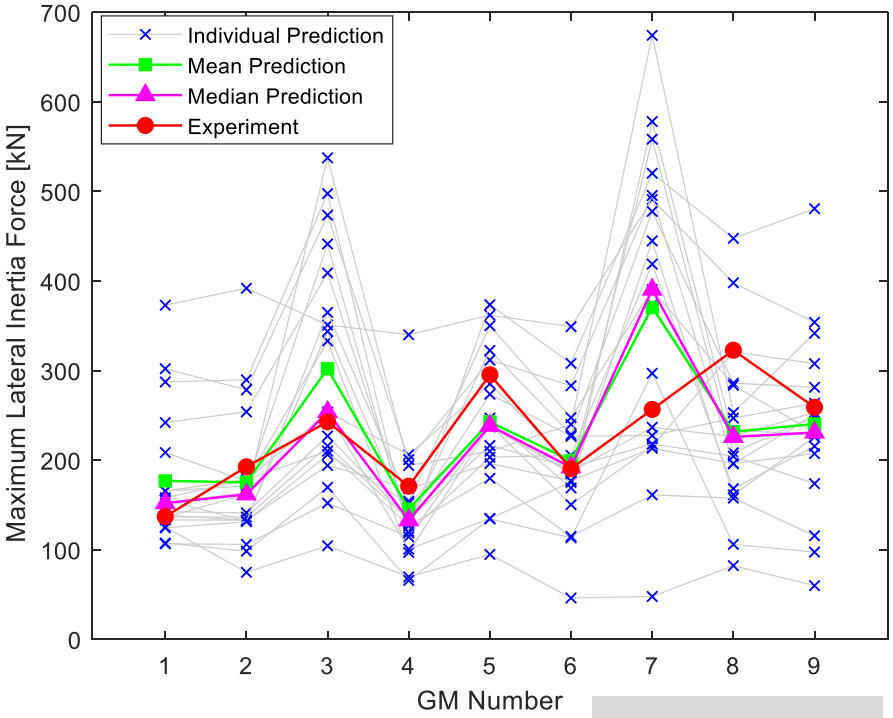
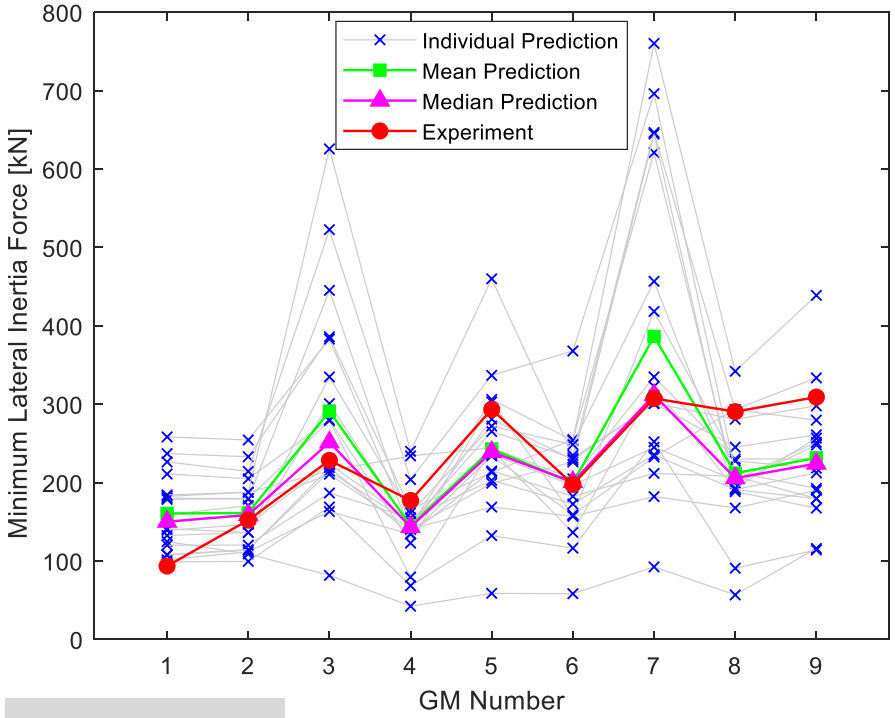
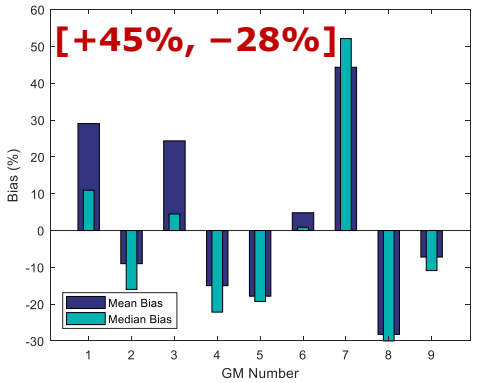
Sample Results



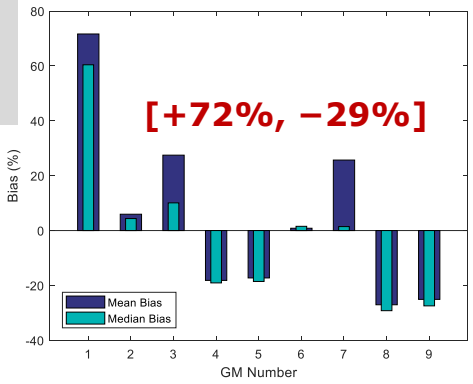




Max. Lateral Inertia Force

Min. Lateral Inertia Force

$$Bias = \frac{Predicted - Measured}{Measured}$$



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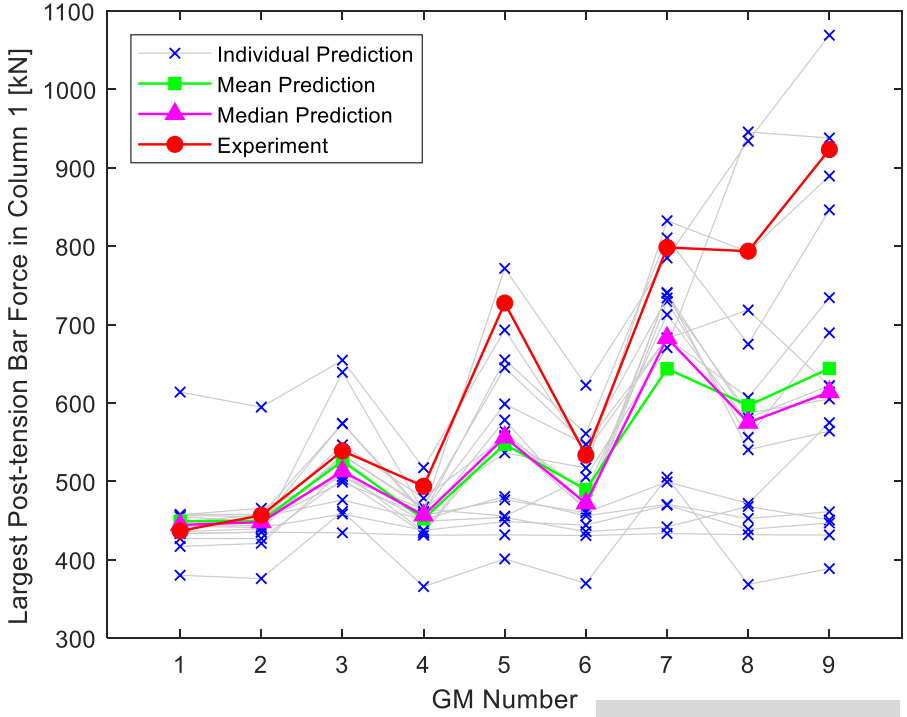
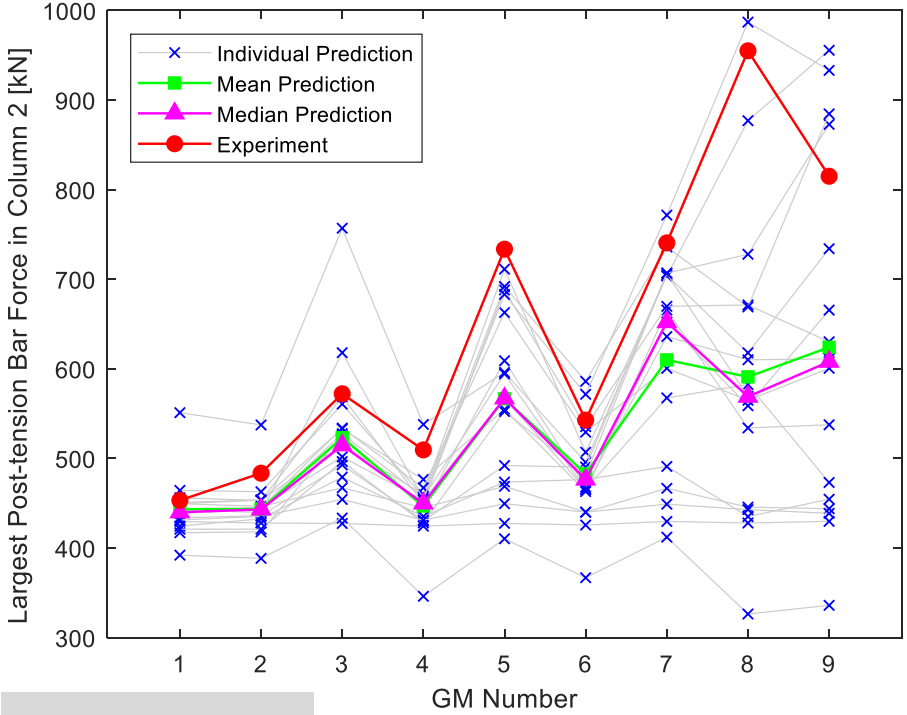
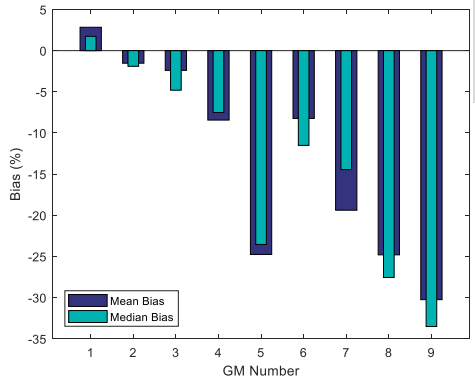
Sample Results



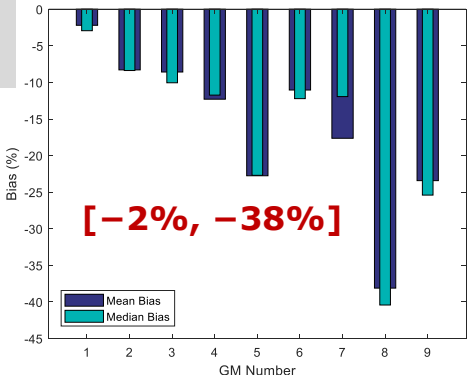


Max. PT force in Column 1

Max. PT force in Column 2



$$Bias = \frac{Predicted - Measured}{Measured}$$



[+3%, −30%]

[−2%, −38%]

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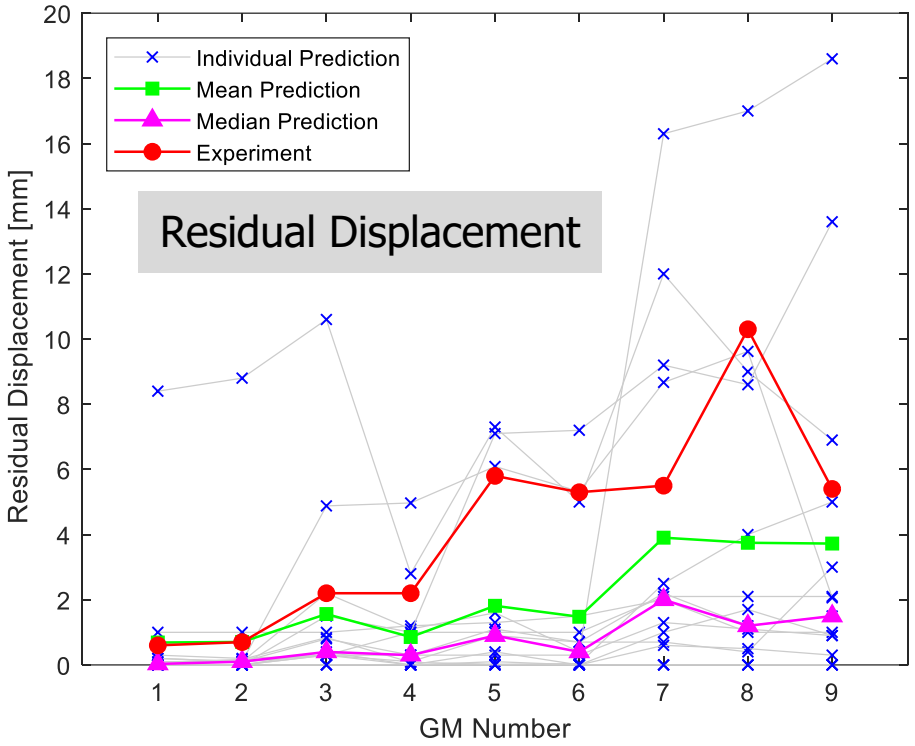
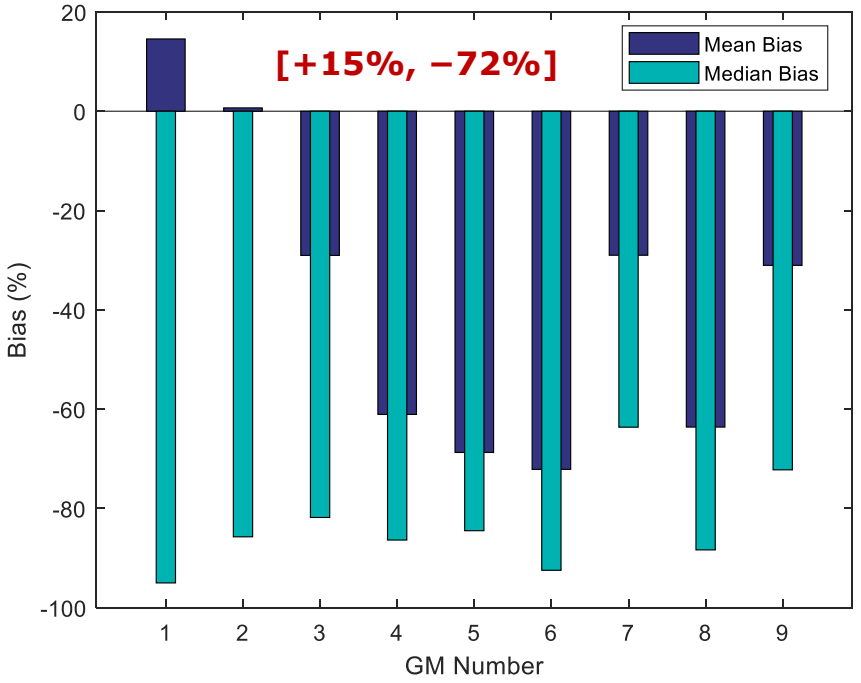
Sample Results



More blind predictions are needed for:

- Analytical & experimental studies
- Field testing & data



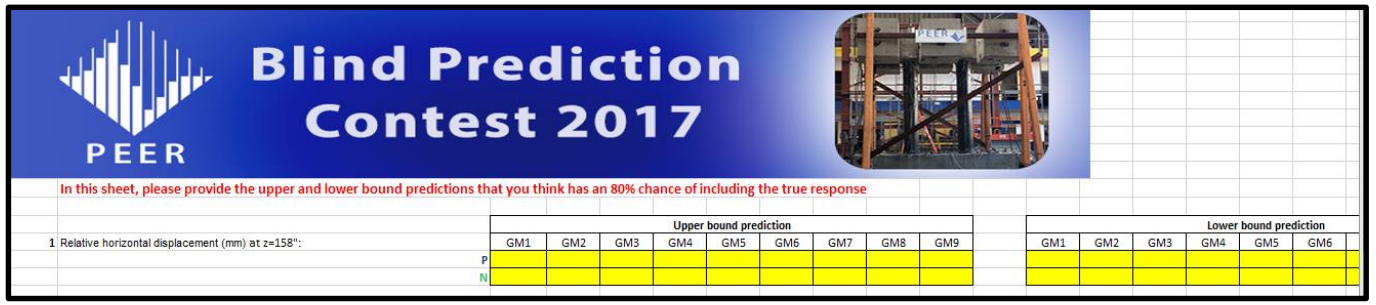
$$Bias = \frac{Predicted - Measured}{Measured}$$

Check http://peer.berkeley.edu/ for future **2018-2028** (sometime in **Fall**) PEER Blind Prediction Contests

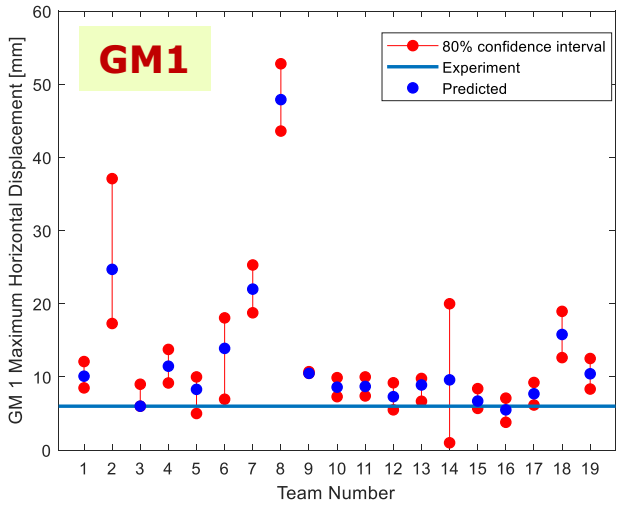
The Survey

Additional information sought from contestants in a form of a survey included:

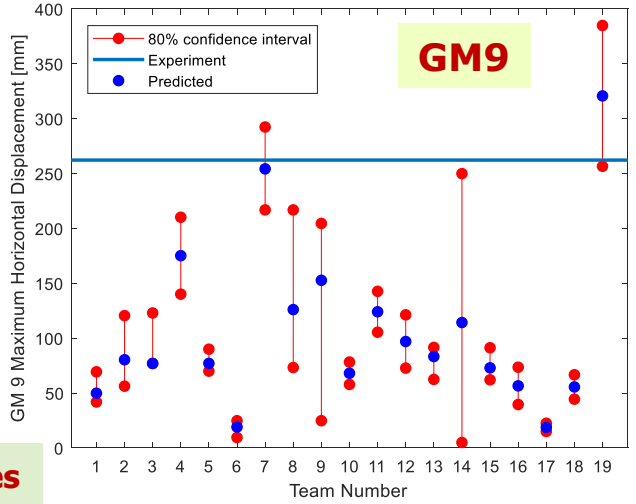
- ❑ Nonlinear analysis program used
- ❑ Column modeling
- ❑ Cap beam modeling
- ❑ Footing modeling
- ❑ Post-Tension bar modeling
- ❑ Mass block formulation
- ❑ Rotational mass
- ❑ Damping model
- ❑ Damping ratio
- ❑ Integration scheme
- ❑ Integration time-step
- ❑ Second-order effects
- ❑ 80% Confidence estimations



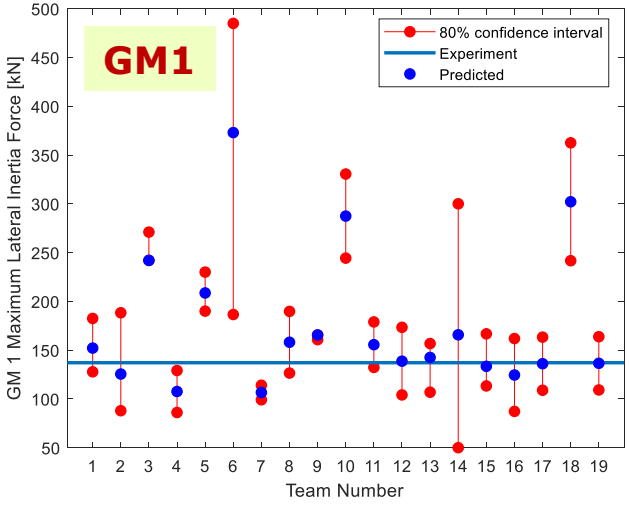
More Sample Results



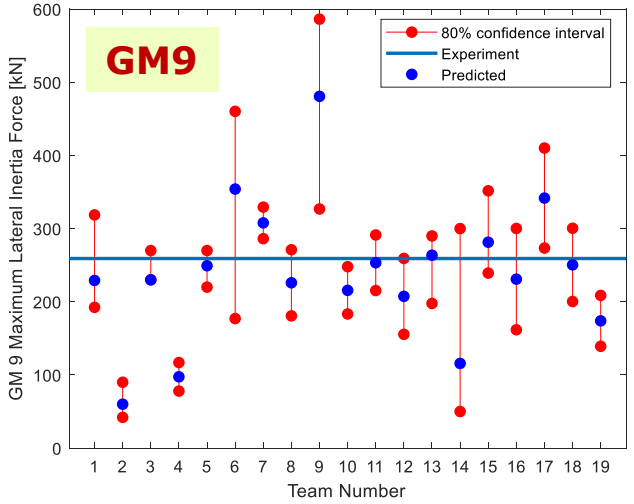
Max. Horizontal Displacement



80% conf. estimates are self-reported.



Max. Lateral Inertia Force



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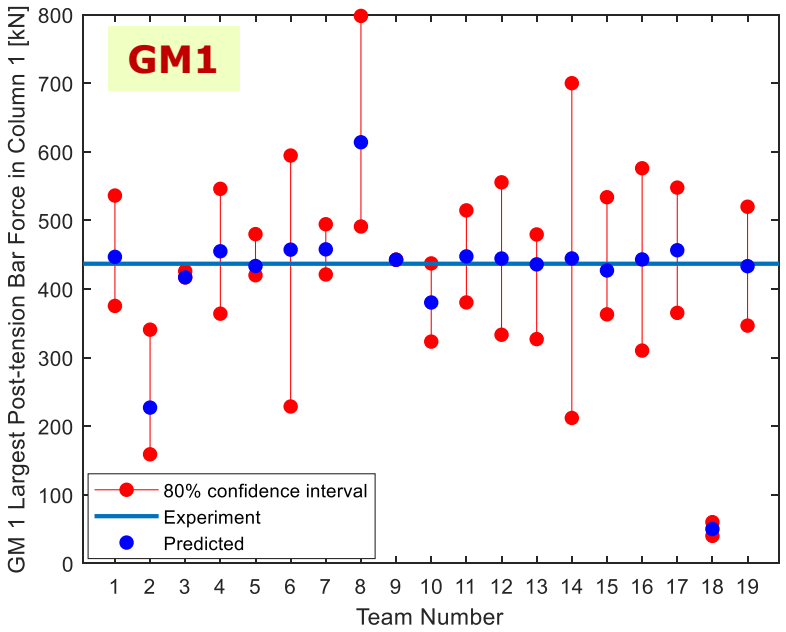
More Sample Results



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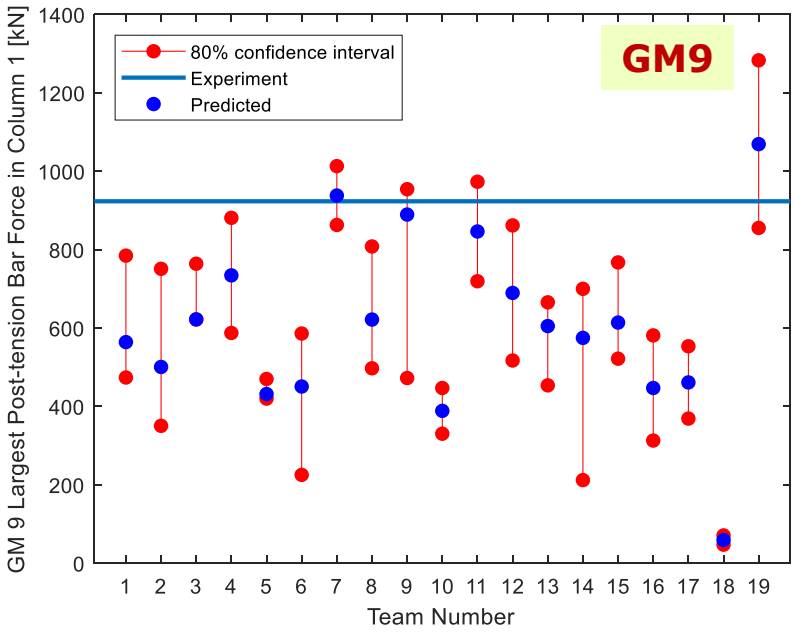
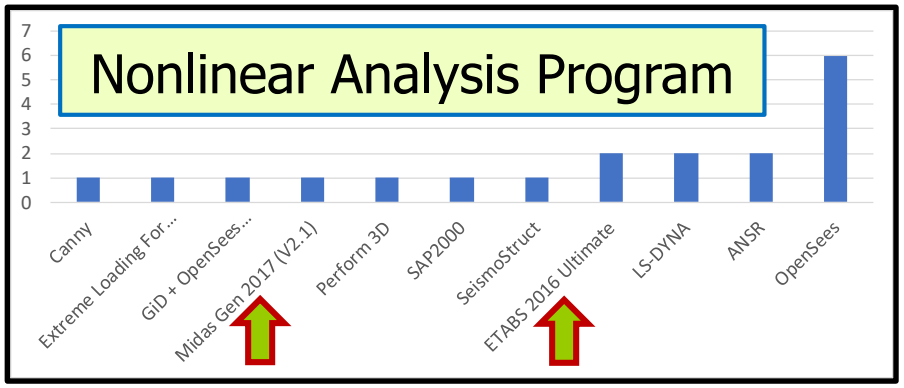
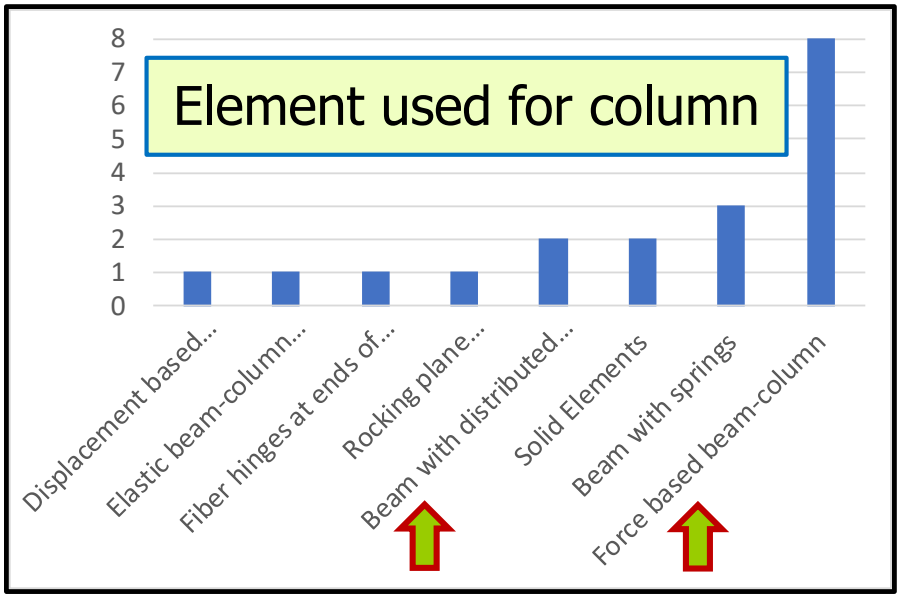
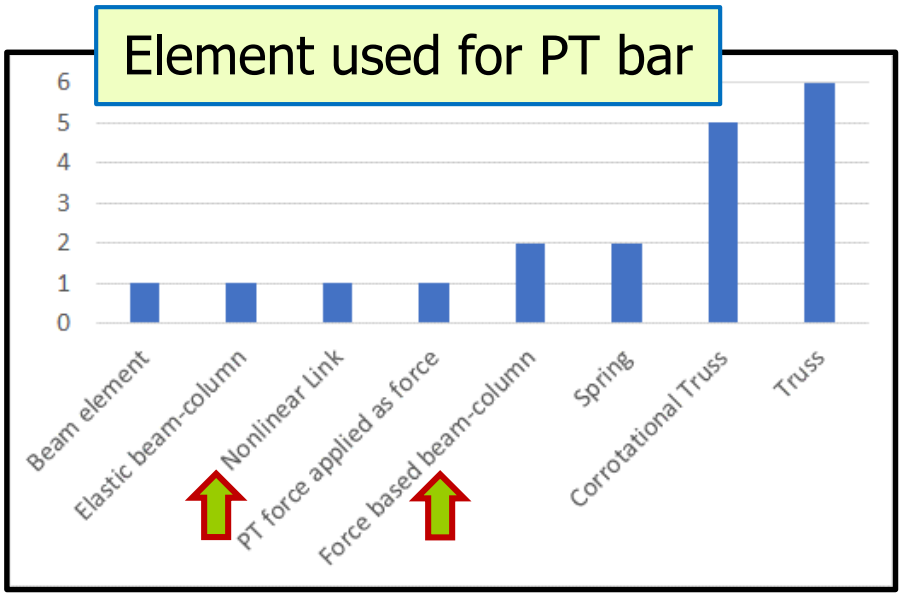


Max. PT Force in Column 1

Survey Statistics







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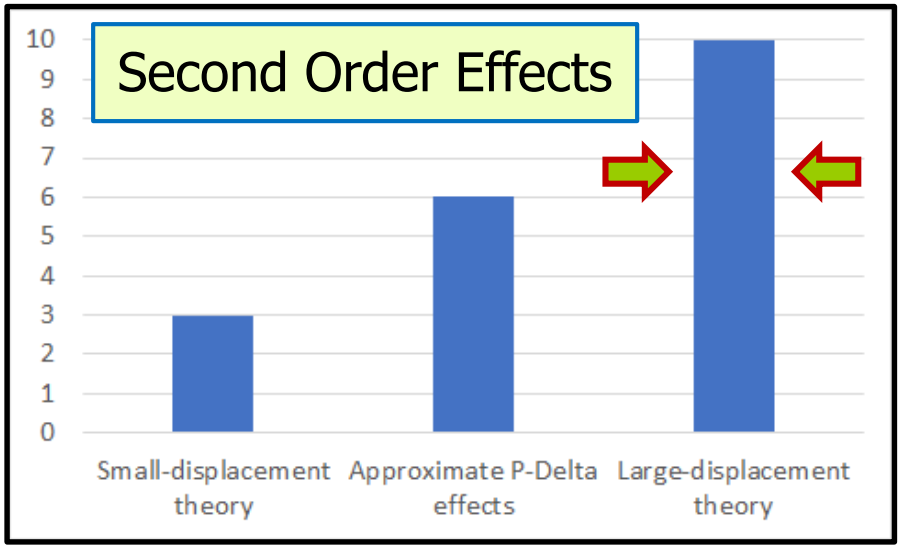
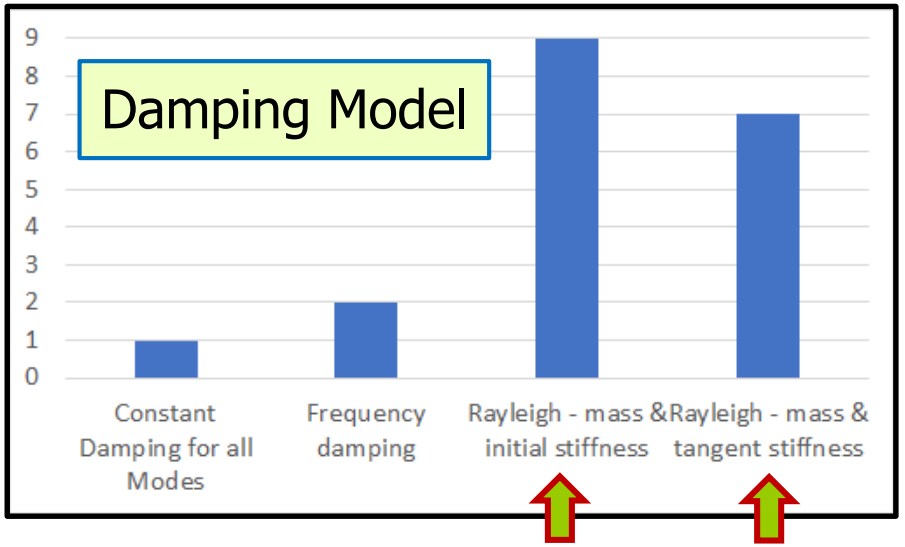
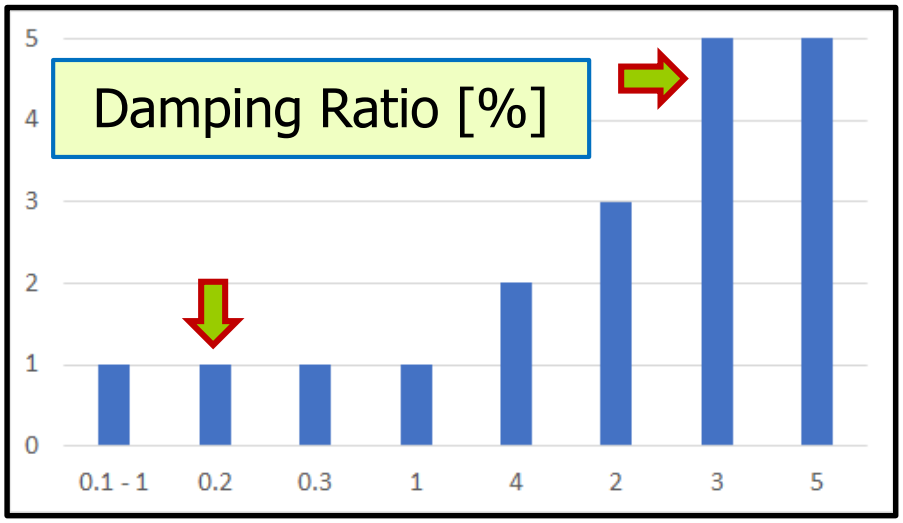
Survey Statistics







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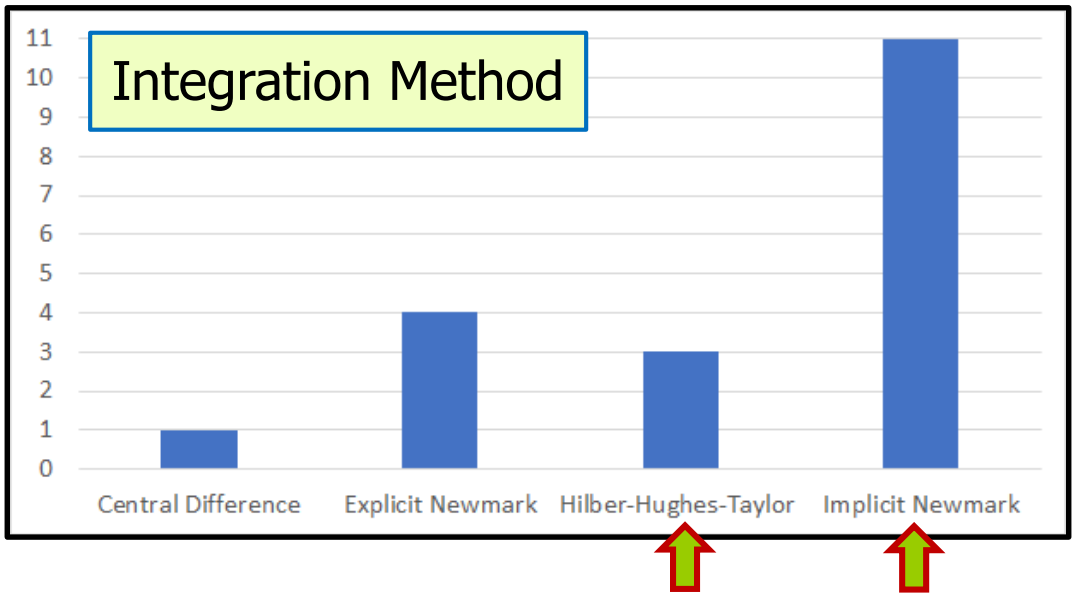
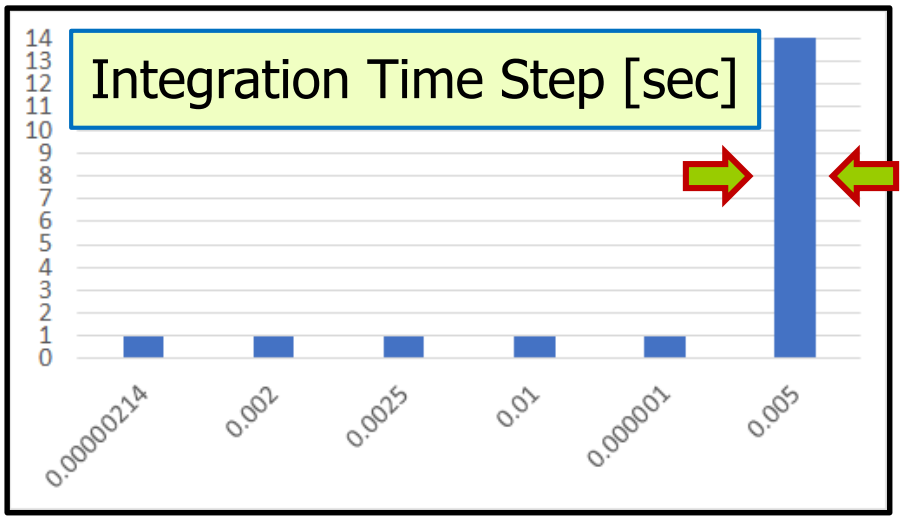
Survey Statistics





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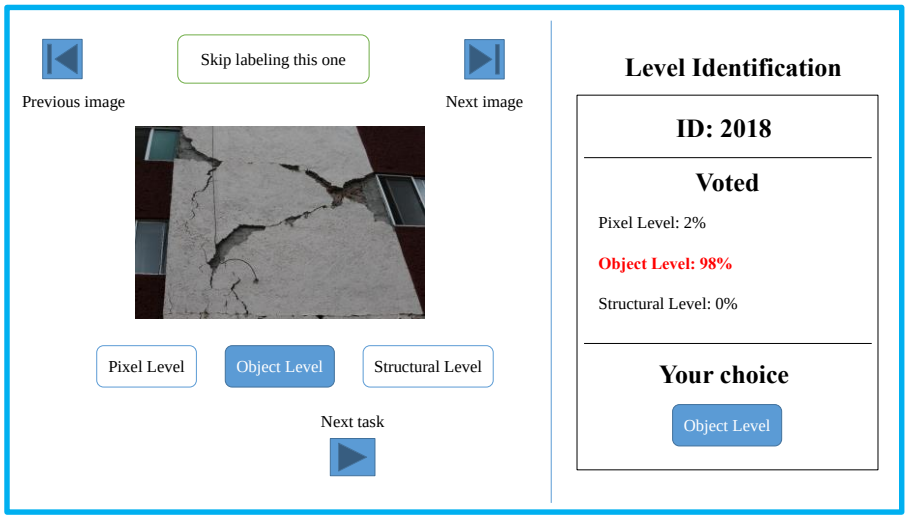
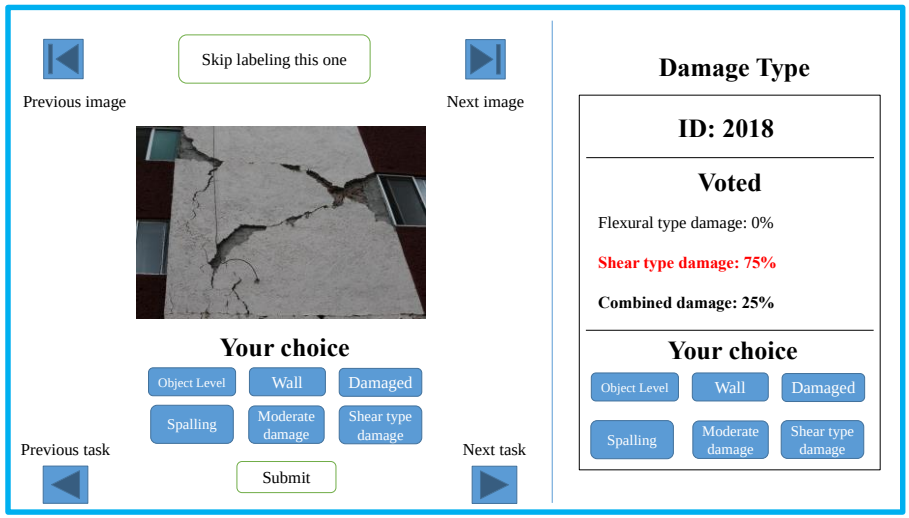
PEER Hub Image (PHI) 2018 Φ-Challenge

- ✓ PEER will hold this annual image challenge where each team will complete several multi-classification tasks and a localization task.
- ✓ More than **20,000** labeled images will be provided as training data to the contestants.
- ✓ Detection performance will be evaluated on test images, for which labels will not be provided.
- ✓ Prediction results will be accompanied with a brief report including algorithm/method that should be submitted at the same time.

Call for Contribution to 2018 Φ-Challenge

- Call for uploading images to SPO website, http://peer.berkeley.edu/spo
- Labeling images by a new web application (**under development**) on SPO website





Thank You, Enjoy The Poster Session

	Thursday January 18	Friday January 19	
8:00 - 8:30 am	REGISTRATION / BREAKFAST	REGISTRATION / BREAKFAST	
8:30 - 9:00 am	PLENARY - 1 ***PEER Overview***	PLENARY - 7 ***Opening & Keynote Presentation***	
9:00 -10:30 am	PLENARY - 2 ***Earthquake Hazard Characterization***	CONCURRENT DISCUSSION - C1 ***Buildings***	CONCURRENT DISCUSSION - C2 ***Characterization of Geohazards***
10:30 - 10:45 am	BREAK	BREAK	
10:45 - 12:15 pm	PLENARY - 3 ***Performance-Based Engineering: Applications***	CONCURRENT DISCUSSION - C3 ***Bridges***	CONCURRENT DISCUSSION - C4 ***Designing for GeoHazards***
12:15 - 1:30 pm	LUNCH & Special Presentation	LUNCH & Special Presentation	
1:30 - 3:00 pm	PLENARY - 4 ***Performance-Based Engineering: Research***	PLENARY - 8 ***Computational Simulation***	
3:00 - 3:15 pm	BREAK	BREAK	
3:15 - 4:45 pm	PLENARY - 5 ***Engineering and Public Policy for Earthquake Resilient Communities***	PLENARY - 9 ***Reports & Wrap Up*** ***Adjourn at 4:00 pm***	
4:45 - 5:00 pm	PLENARY- 6 ***Closure & Wrap Up*** ***2017 Blind Prediction Contest Winner***		
5:30 - 7:30 pm	Poster Session & Reception		
6:30 - 8:30 pm	**BIP Dinner** **(invitation only)**		