



**NATIONAL TECHNICAL UNIVERSITY OF ATHENS
SCHOOL OF CIVIL ENGINEERING
DEPARTMENT OF STRUCTURAL ENGINEERING**



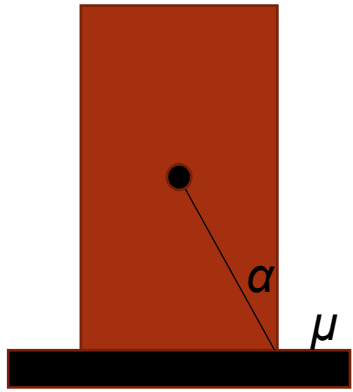
Sliding and Rocking are not the same

Christos G. Lachanas and Angeliki Gerontati

49th Risk, Hazard and Uncertainty Workshop
HYDRA, 15-16 June 2023

Rocking vs Sliding

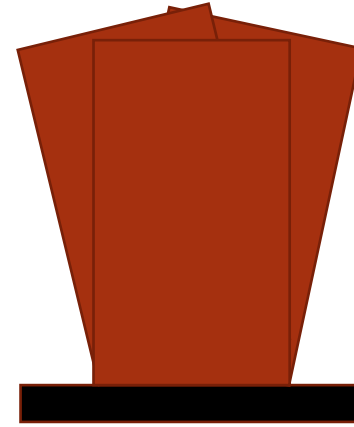
Rigid block resting on a rigid base



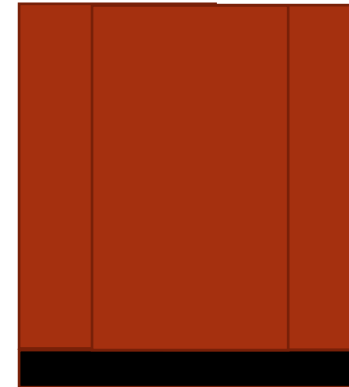
Base excitation

$\alpha < \mu$

$\alpha > \mu$



It rocks!!



It slides!!



Rocking vs Sliding

- Various structures/contents undergo rocking or sliding during earthquakes

Ancient monuments



source: Wikipedia

Rack pallets (Castiglioni et al., 2018)



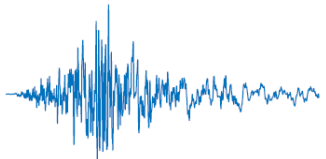
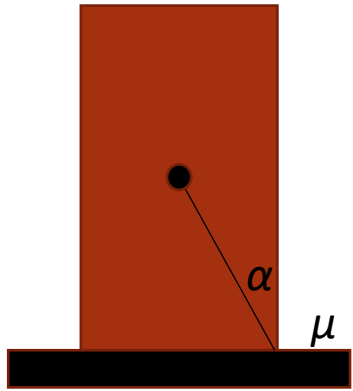
Anchorage
???

- Not easy applicable
 - Not always beneficial
- rocking/sliding → effective seismic isolation



Rocking vs Sliding

Rigid block resting
on a rigid base



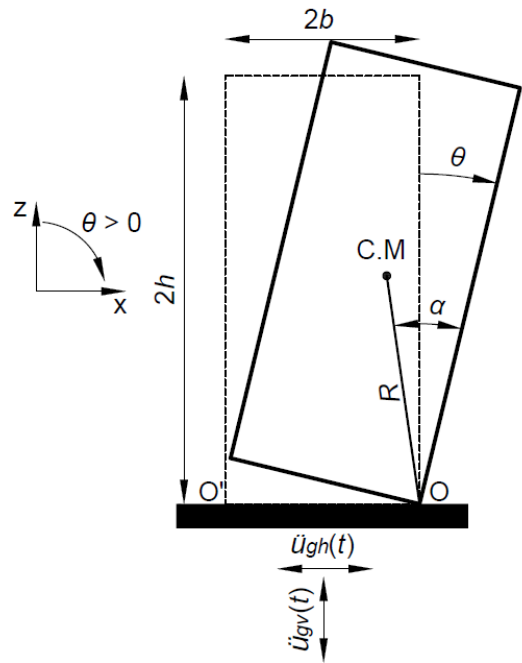
Base excitation

- A lot of structures at seismic risk
- A lot of analytical studies
- Probabilistic treatment → Need for answers
(How many analyses?!, Is vertical component significant?!, Is there any optimal IM?? etc..)
- Probabilistic lenses...
(Generic models, many analyses, statistical tools)
- Searching for answers...
 - May **not exist** on an **one-by-one** comparison basis
 - May **exist** on a **population-by-population** comparison basis

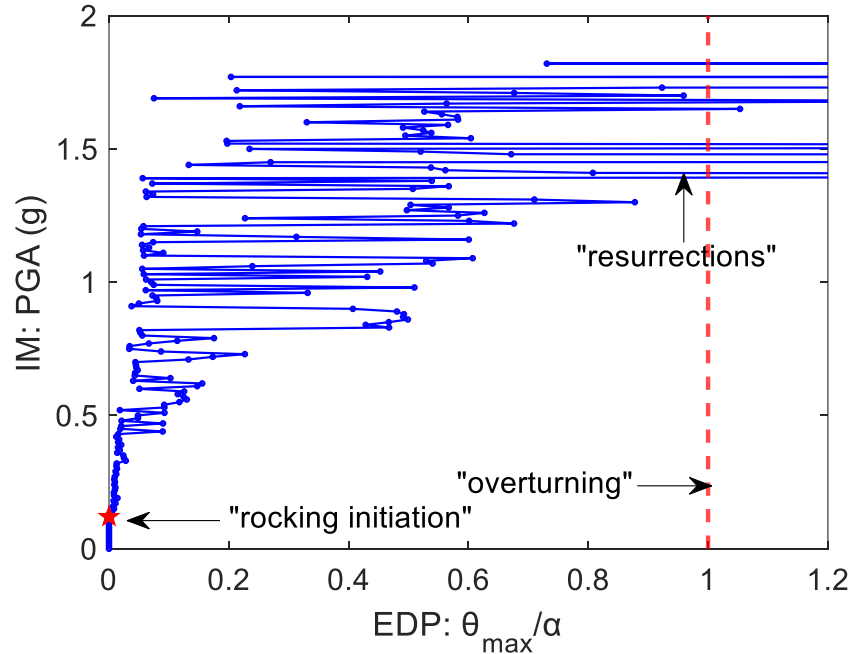


Rocking

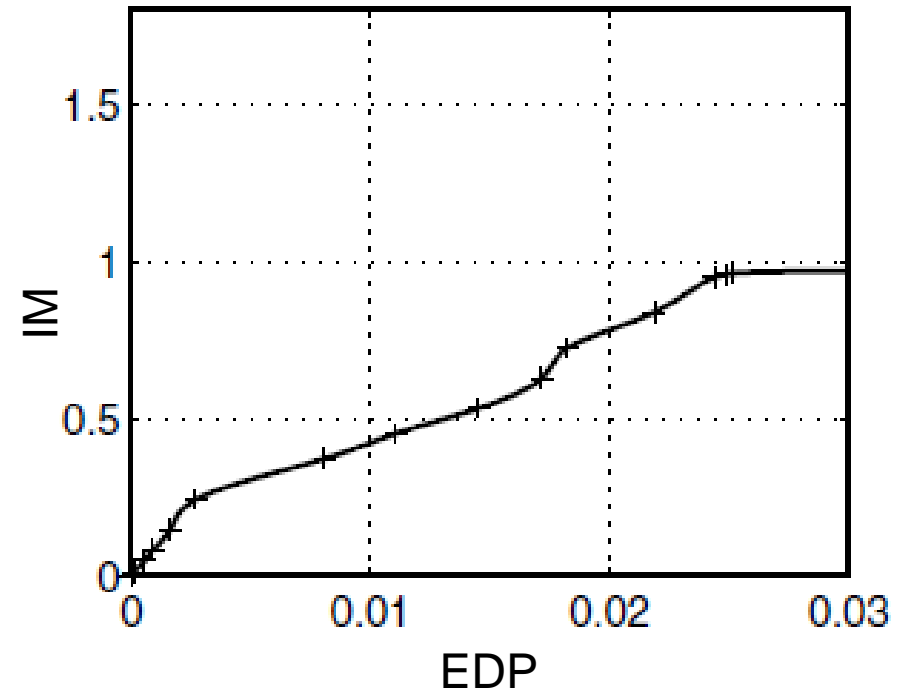
- Rocking dynamics (better ask Dimitrakopoulos, and Vassiliou...)
- All started after running IDA....



Planar rocking block model



Typical Rocking IDA curve



Typical IDA curve (yielding system)
(Vamvatsikos and Cornell 2002)

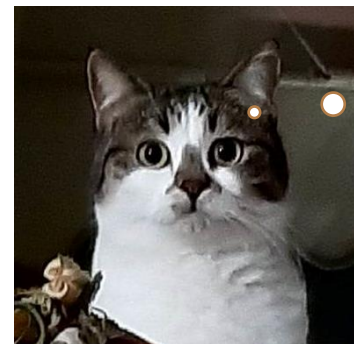
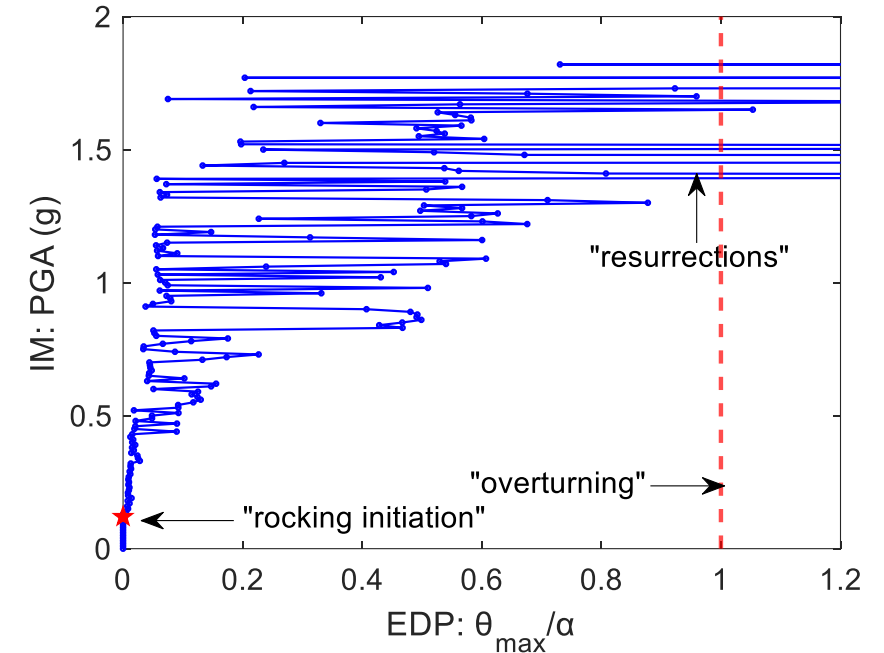


Rocking

- Seismic response standardization:
- ✓ Running and post-processing **Rocking IDA**
- ✓ **Statistical property parametrization** [Normalize out parameters, **statistical distribution** for rocking fragilities (**lognormal/shifted lognormal**)]
- ✓ **IMs** for rocking vulnerability studies (**PGA, PGV, AvgSa**)
- ✓ Influence of the **vertical component** of the ground motion (**uplift of stocky blocks**)
- ✓ Closed-form **equations** for rocking fragilities (**on-earth blocks, building contents**)

Lachanas CG. (2022). PhD thesis, NTUA

Typical Rocking IDA curve

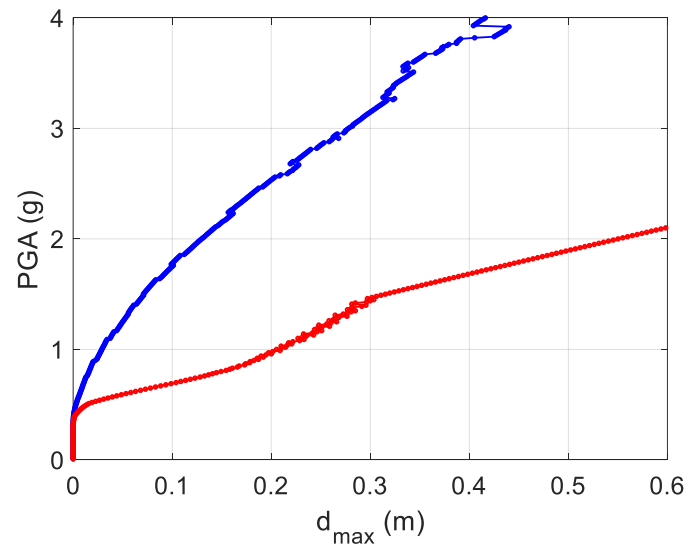
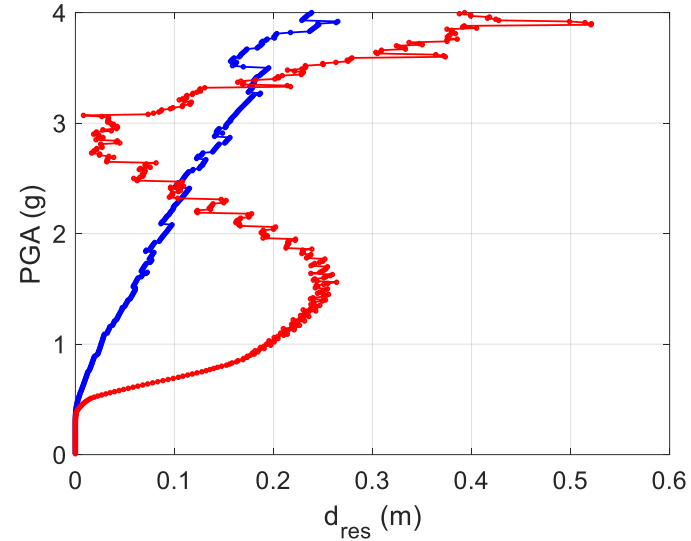
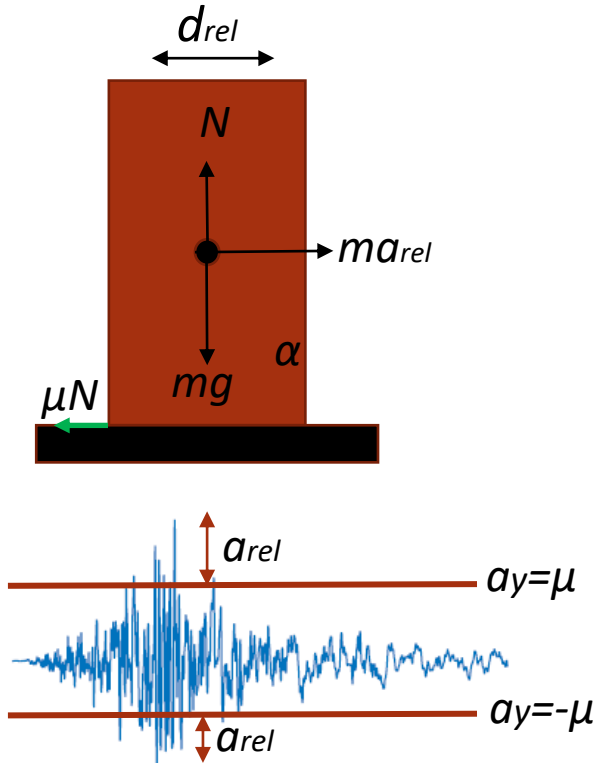


½ slot...

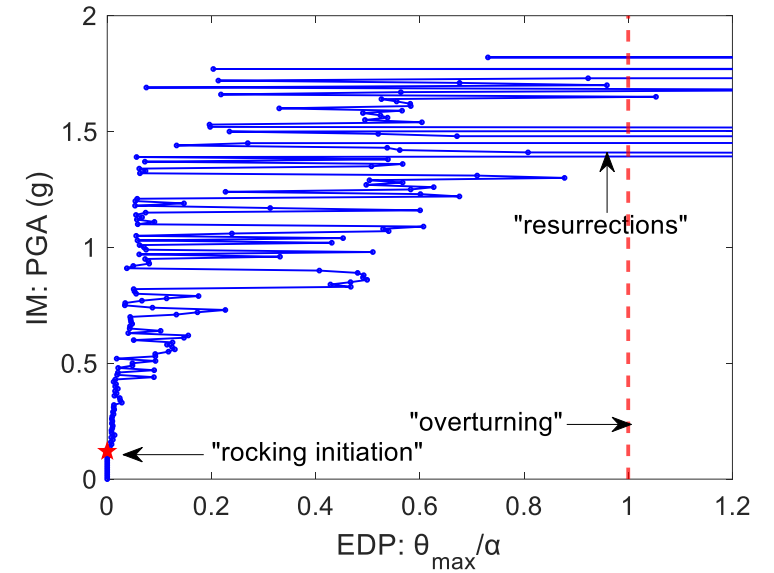


- Again, let's try to run IDA....

Sliding block model



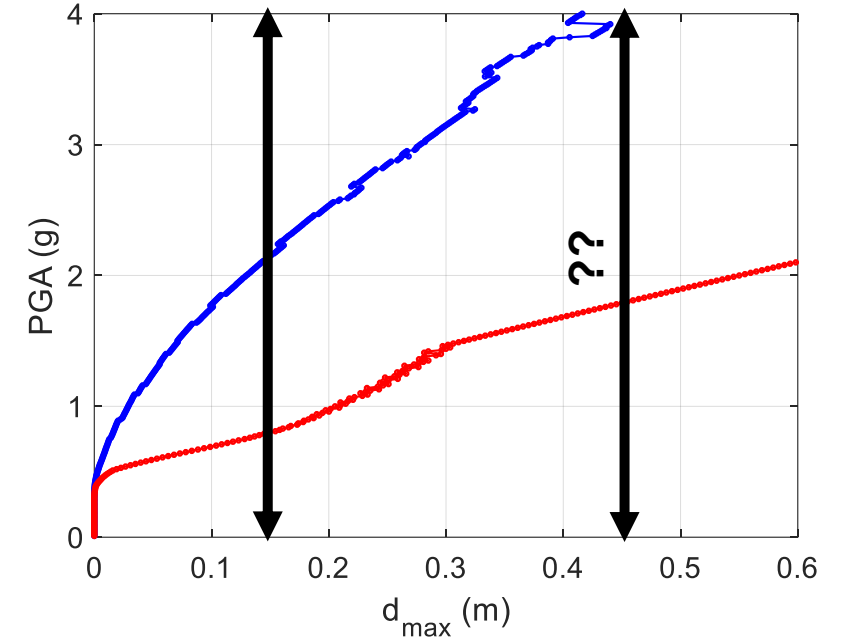
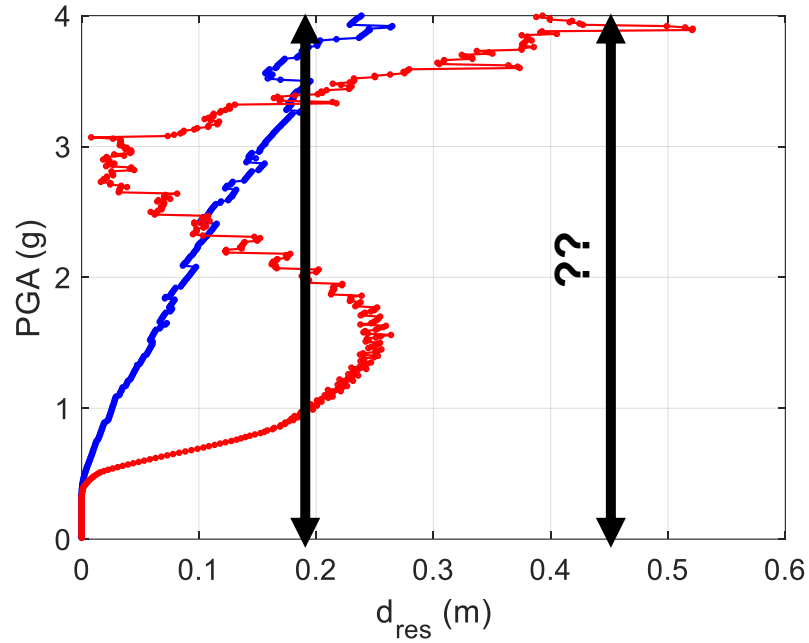
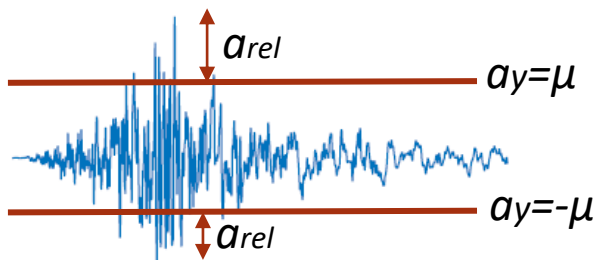
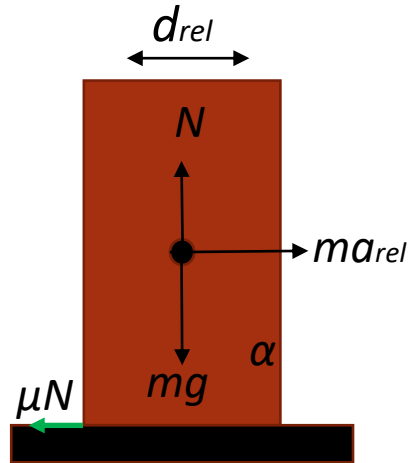
Typical Rocking IDA curve



- Different shape
- "Collapse" level?
- Scaling artefacts?



Sliding block model



• Not a specific collapse level → Vertical statistics???

- Check and revisit the proposed tools for rocking
- Propose new tools
- Standardization of sliding response

**STAY
TUNED...**



Conclusions

- Rocking and Sliding consider many structures at seismic risk
- Need for standardization of rocking/sliding response → PBEE framework
- Rocking → We have some results...
- Sliding → We are in progress...

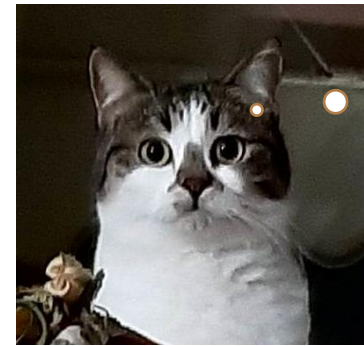
Special thanks to:

Dimitrios Vamvatsikos → PBEE expert...

Elias Dimitrakopoulos, Michalis Vassiliou → Rocking experts...

Athanasia Kazantzi → Fitting expert....

Dimitrios Tsarpalis → Sliding modeler...



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METIS

