NGL Susceptibility Database and Modeling

Jonathan P. Stewart

with Arda Sahin, Scott J. Brandenberg, Armin W. Stuedlein, Amalesh Jana, Steven L. Kramer, Kristin J. Ulmer, T. Matthew Evans

PEER Researchers Meeting
Richmond Field Station
August 16, 2024

Outline

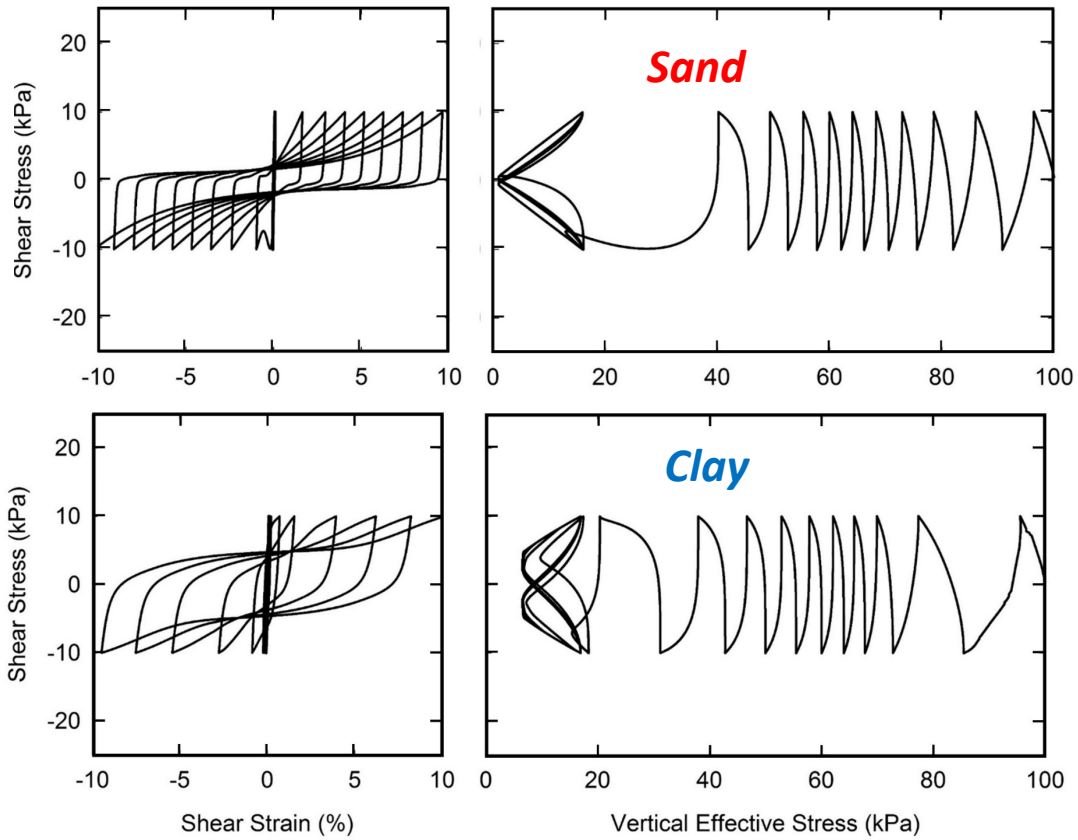
- Research objective and scope
- Incorporation of susceptibility data in NGL Database
- Visualization tool for laboratory test results

Research Objective

Cyclic soil behavior for sand and clay are different

Different methods used to assess potential for strength loss

Susceptibility analyses are used to assess soil behavior type, which controls the subsequent analysis methods



Kramer & Stewart (2024)

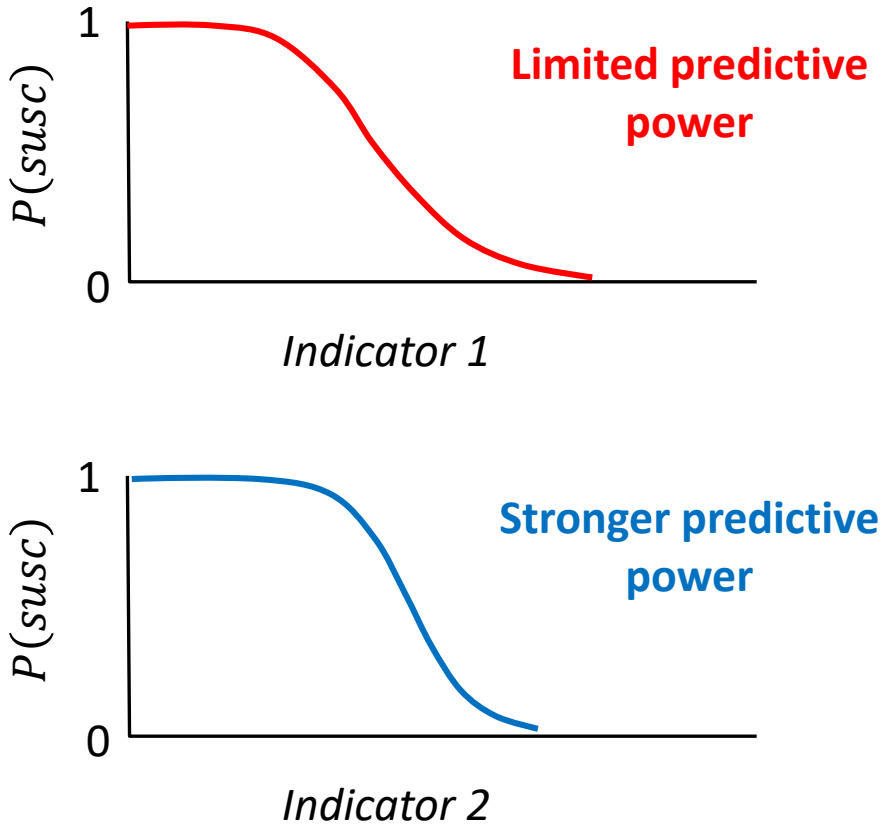
Research Objective

Cyclic soil behavior for sand and clay are different

Different methods used to assess potential for strength loss

Susceptibility analyses are used to assess soil behavior type, which controls the subsequent analysis methods

Objective: identify indicators to predict $P(susc)$ and derive probabilistic models



Project Scope

Adapt laboratory component of NGL database for relevant data:

- Site
- Boreholes with samples and CPT soundings
- Laboratory cyclic and index test data
- Not required: field performance data and ground motions

NGL database: Brandenberg et al. (2020); Ulmer et al. (2023)

Project Scope

Adapt laboratory component of NGL database for relevant data:

Develop data resources for project

- Identify data sources, work with investigators on permissions, data transfer, digitization, data publication
- Interpret data to support model development

Project Scope

Adapt laboratory component of NGL database for relevant data:

Develop data resources for project

Model development

- Identify potential indicators: lab test index parameters (PI), lab test monotonic parameters (Su normalization), CPT parameters (I_c, I_B)
- Interpret data to support model development: Outcome = model for $P(susc)|(indicators)$

Project Scope

Adapt laboratory component of NGL database for relevant data:

Develop data resources for project

Model development

Documentation, dissemination

Status: we are near the end of year 1 of a two-year project

Outline

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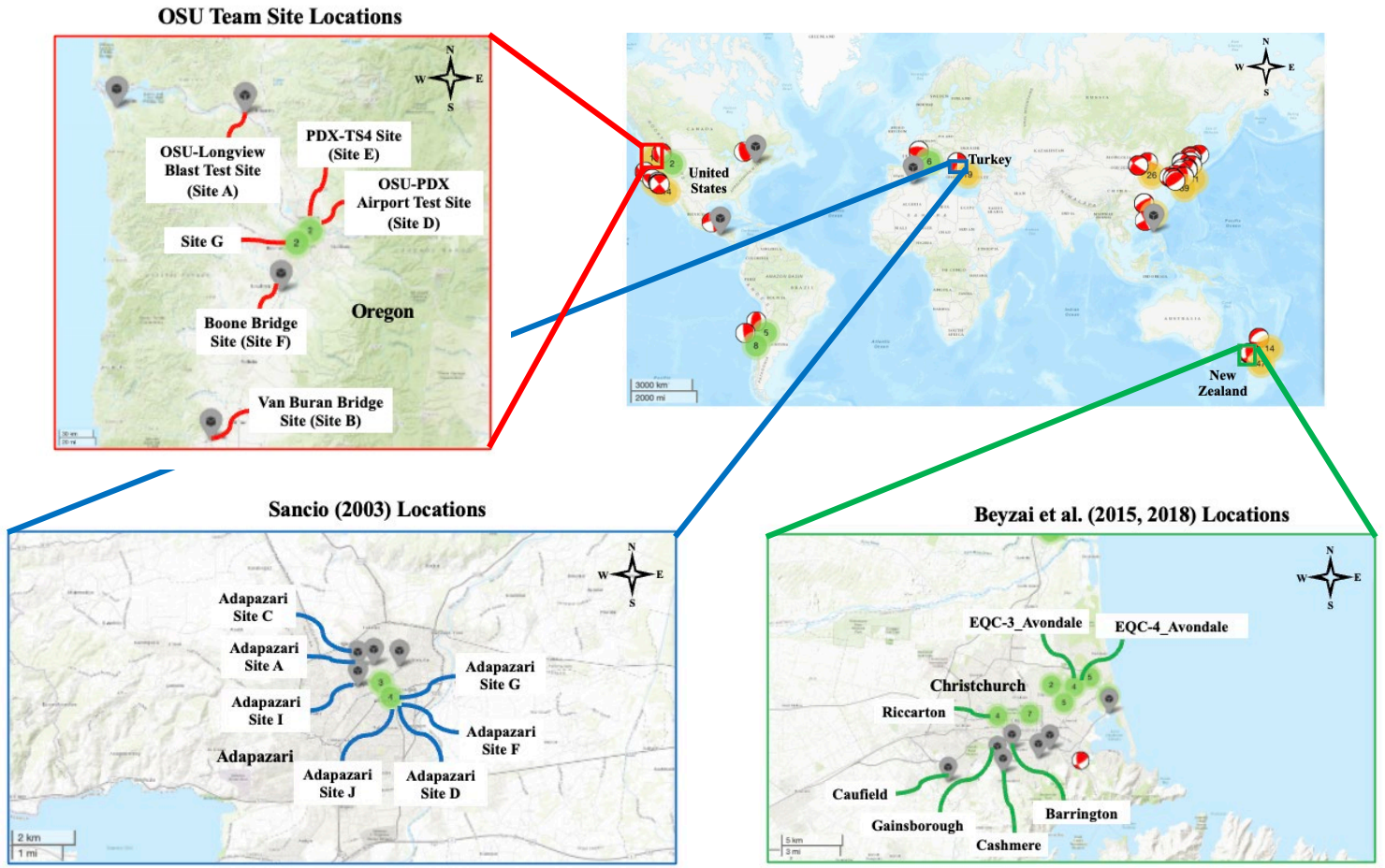
- **Incorporation of susceptibility data in NGL Database**
- Visualization tool for laboratory test results

Large datasets in NGL database

Sancio (2003) dataset – after 1999 Kocaeli earthquake – both CTX and CDSS data

Beyzaei (2017) dataset – after 2010 – 2011 Canterbury earthquake sequence – only CTX

Stuedlein et al. (2023b) dataset - several projects in the Pacific Northwest – only CDSS



Sancio (2003) Dataset – 1999 Kocaeli EQ

Site	Test Type	Number of Specimens	Liquid Limit, LL (%)	Plasticity Index, PI (%)
Adapazari Site A, Türkiye	CTX, CDSS	23, 3	27 – 69 (41.2)	NP – 45 (15.8)
Adapazari Site C, Türkiye	CTX, CDSS	20, 1	24 – 69 (40.2)	NP – 38 (14.6)
Adapazari Site D, Türkiye	CTX, CDSS	7, 1	25 – 37 (30.3)	NP – 14 (8.4)
Adapazari Site F, Türkiye	CTX	23	22 – 45 (30.6)	NP – 22 (6.7)
Adapazari Site G, Türkiye	CTX, CDSS	8, 7	26 – 37 (31.5)	NP – 14 (8.0)
Adapazari Site I, Türkiye	CTX	16	23 – 71 (38.0)	NP – 36 (11.8)
Adapazari Site J, Türkiye	CTX, CDSS	7,1	23 – 52 (30.6)	NP – 25 (7.0)

- DesignSafe DOI is pending.
- Included in the database

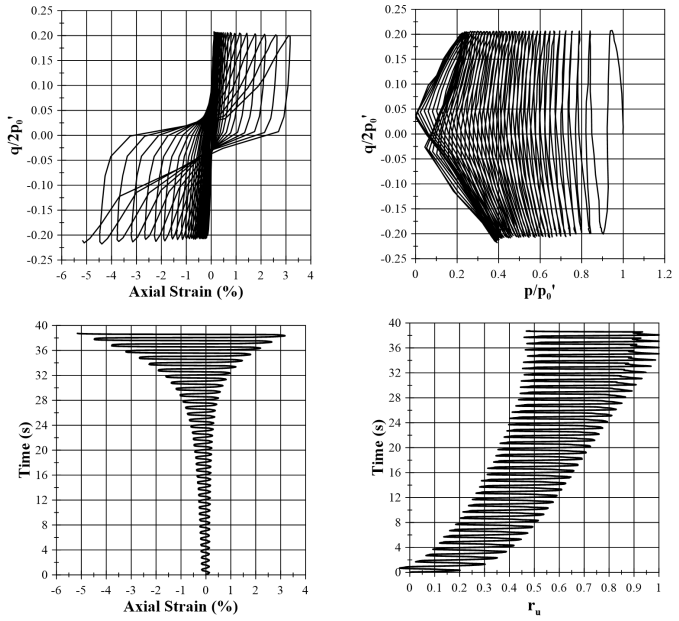
Loading Frequency: 1 Hz

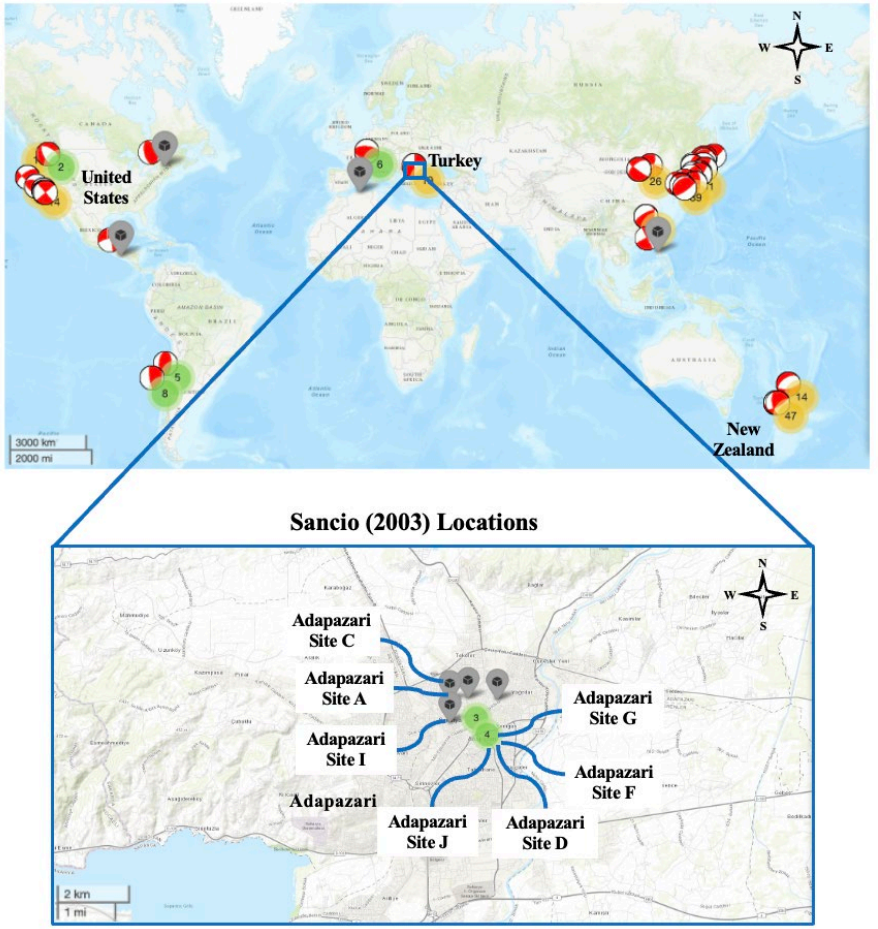
$q/2p_0'$: 0.22

PI: 3%

OCR: 1.0

p_0': 300 kPa





Beyzaei (2017) Dataset – 2010 – 2011 Canterbury EQ Sequence

Site	Test Type	Number of Specimens	Liquid Limit, LL (%)	Plasticity Index, PI (%)
Gainsborough, New Zealand	CTX	5	40 – 42 (41.0)	12 – 16 (14.0)
Barrington, New Zealand	CTX	4	30 – 31 (30.5)	NP – 7 (2.6)
Caulfield, New Zealand	CTX	3	22 – 28 (25.3)	2 – 8 (4.0)
Riccarton, New Zealand	CTX	7	24 – 33 (28.3)	NP – 9 (5.5)
Cashmere, New Zealand	CTX	11	23 – 41 (32.6)	NP – 15 (7.6)
EQC-3_Avondale, New Zealand	CTX	5	-	-
EQC-4_Avondale, New Zealand	CTX	6	-	-

- Data in Beyzaei (2017) supplement
- Included in the database

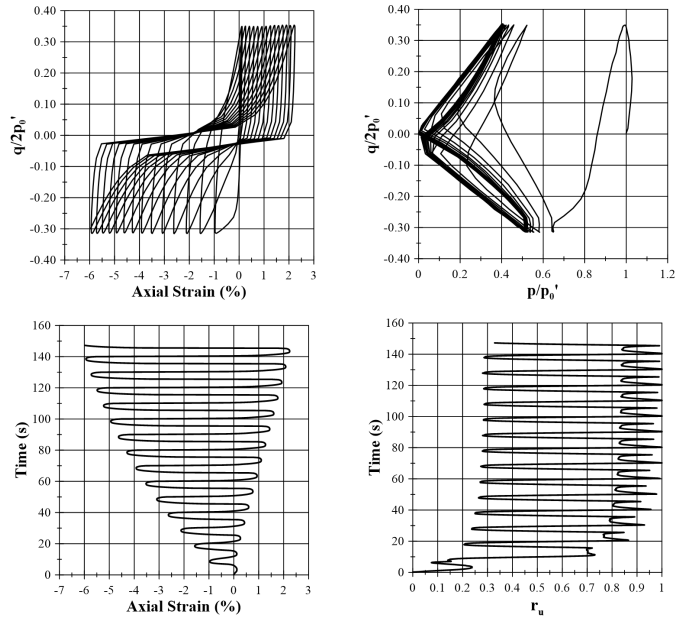
Loading Frequency: 0.1 Hz

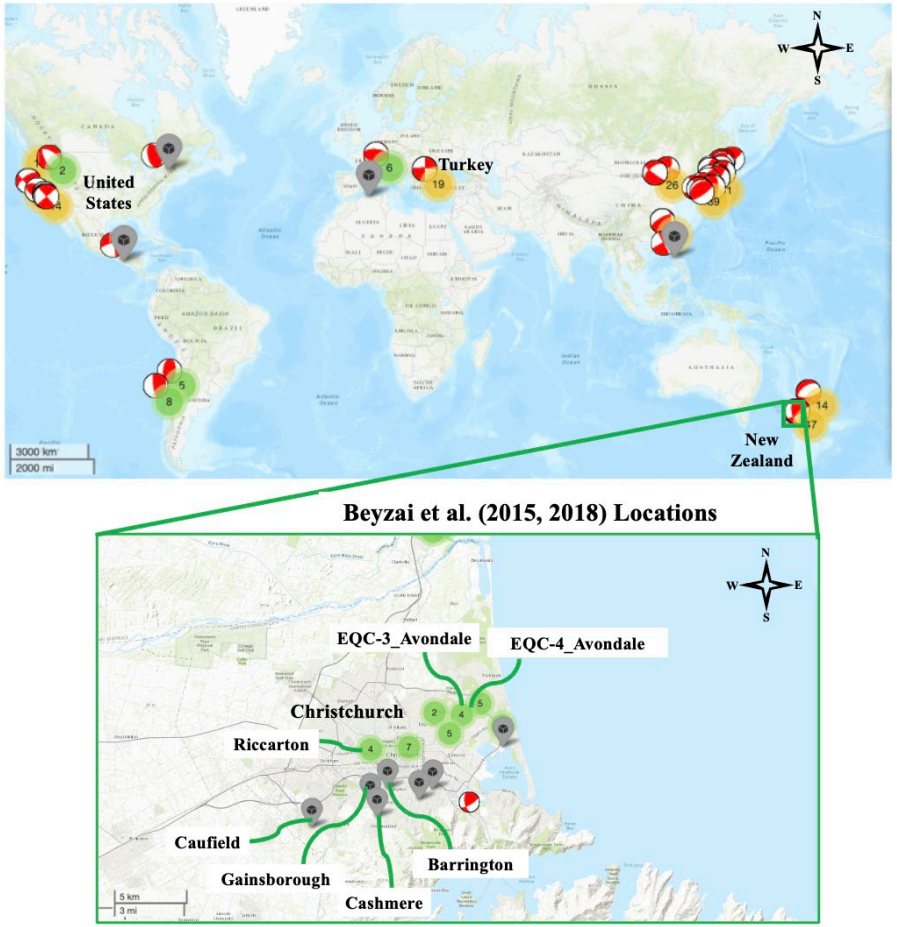
$q/2p_0'$: 0.35

PI: NP

OCR: 1.1

p_0': 88 kPa





Stuedlein et al. (2023b) Dataset – Pacific Northwest Projects

Site	Test Type	Number of Specimens	Liquid Limit, LL (%)	Plasticity Index, PI (%)
OSU-PDX Airport Test Site (Site D), OR, USA	CDSS	12	68 – 78 (70.4)	26 – 29 (27.4)
Van Buren Bridge Site (Site B), OR,USA	CDSS	30	39 – 50 (44.1)	11 – 16 (13.1)
Boone Bridge Site (Site F), OR,USA	CDSS	30	28 – 38 (32)	3 – 11 (5.6)
PDX-TS4 Site (Site E), OR,USA	CDSS	49	39 – 87 (58.7)	12 – 31 (23.6)
OSU-Longview Blast Test Site (Site A), OR,USA	CDSS	56	40 – 51 (46.8)	11 – 19 (14.8)
Site G, OR,USA	CDSS	17	-	-

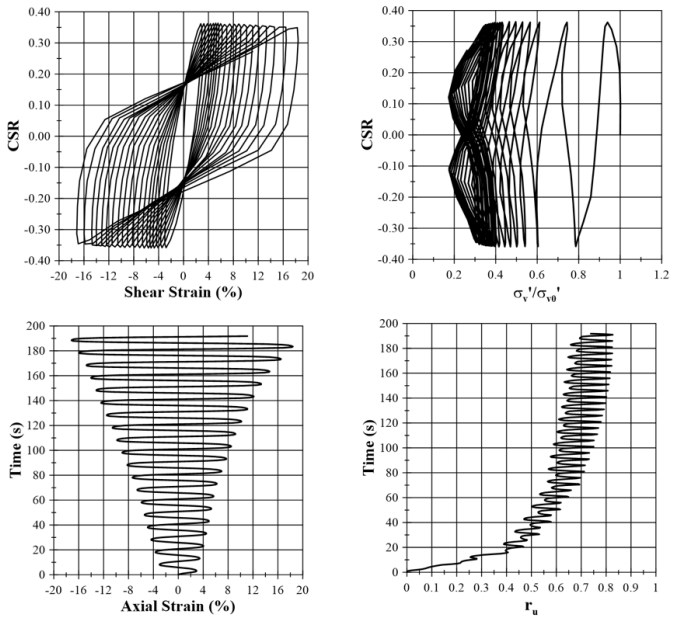
Loading Frequency: 0.1 Hz

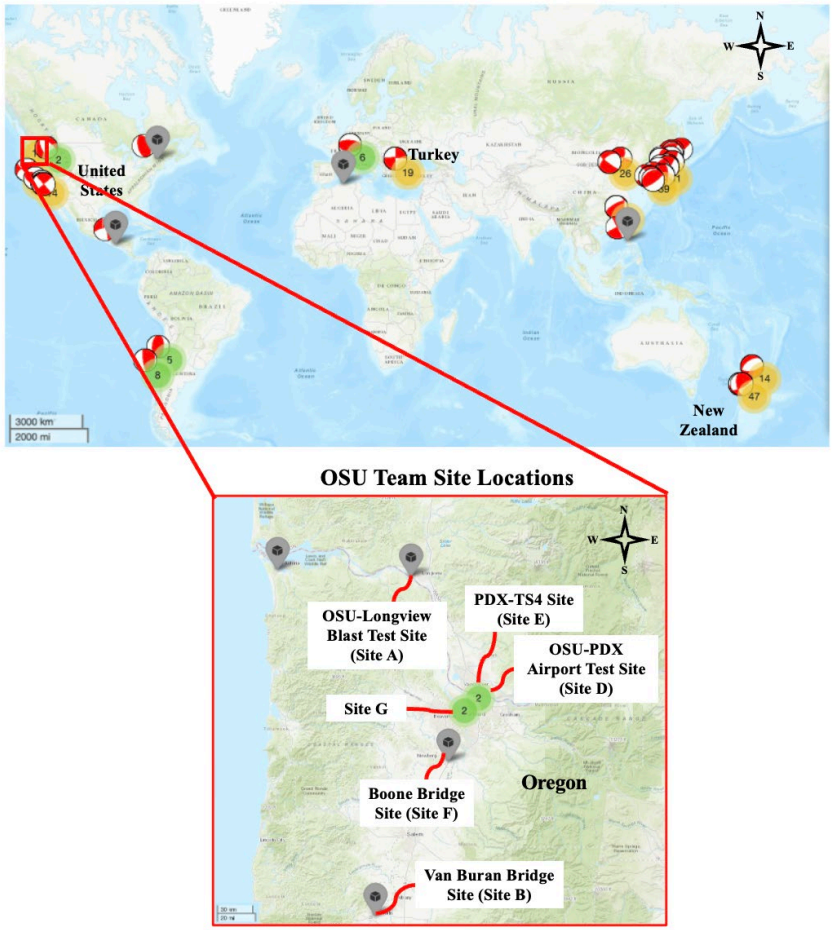
***CSR*: 0.36**

PI: 26%

OCR: 1.9

p_0'**: 79 kPa**





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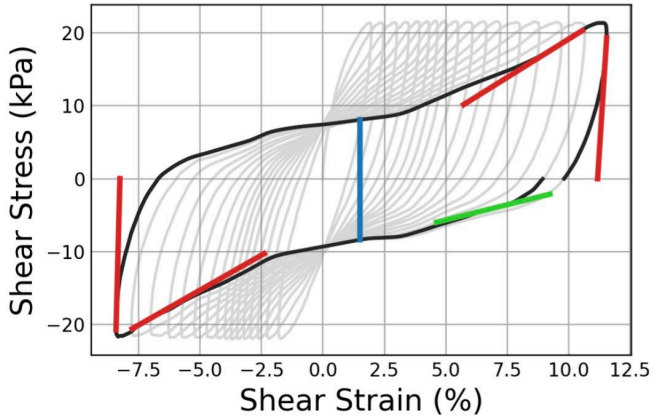
Data Visualization

Jupyter notebook - interacts with NGL database (beta)

Reads data files, generates relevant plots



Data source: Stuedlein et al. (2023b)

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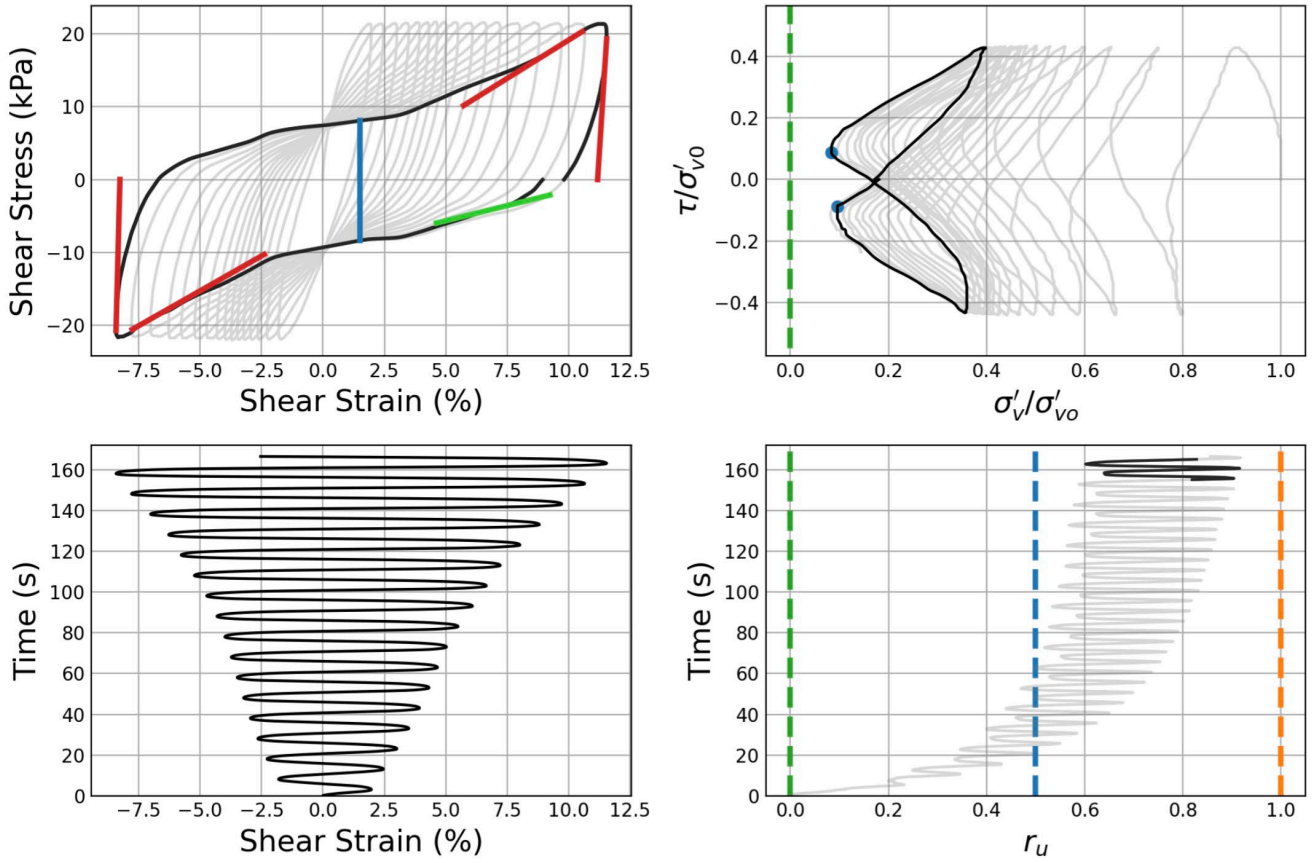


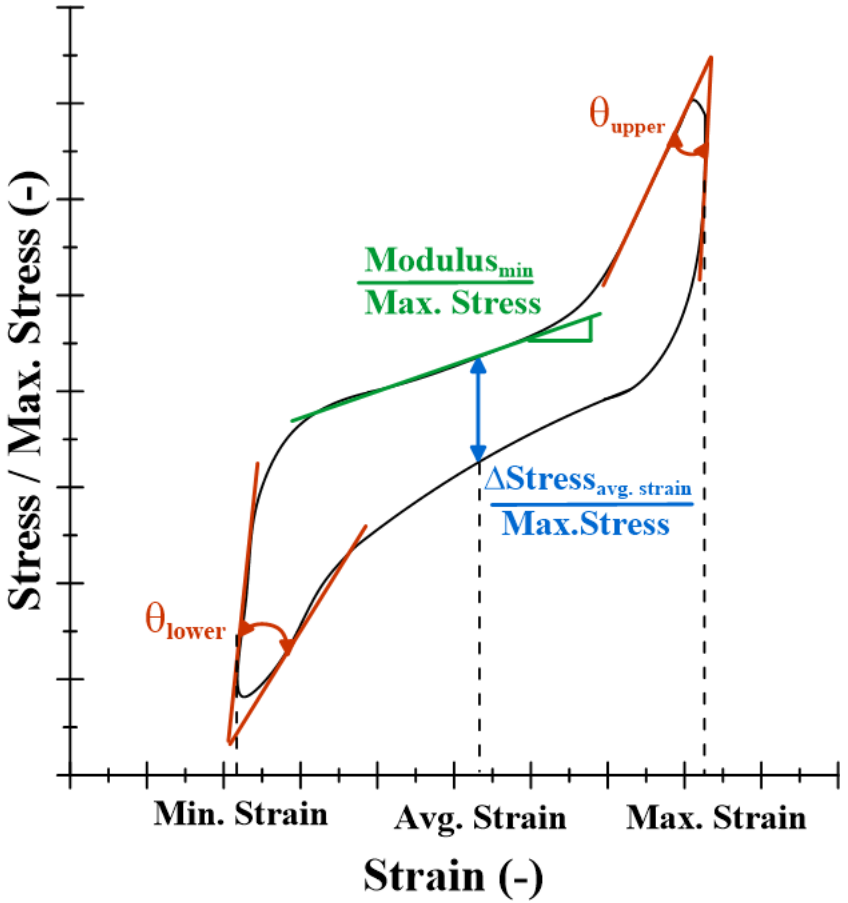
Data source: Stuedlein et al. (2023b)

Data Visualization

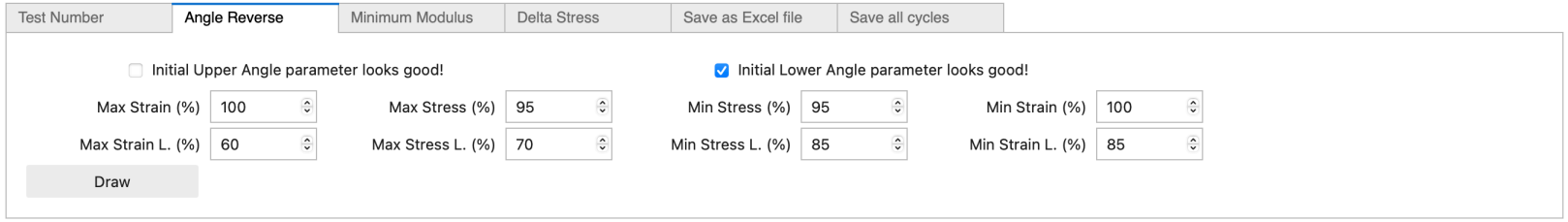
Jupyter notebook - interacts with NGL database (beta)

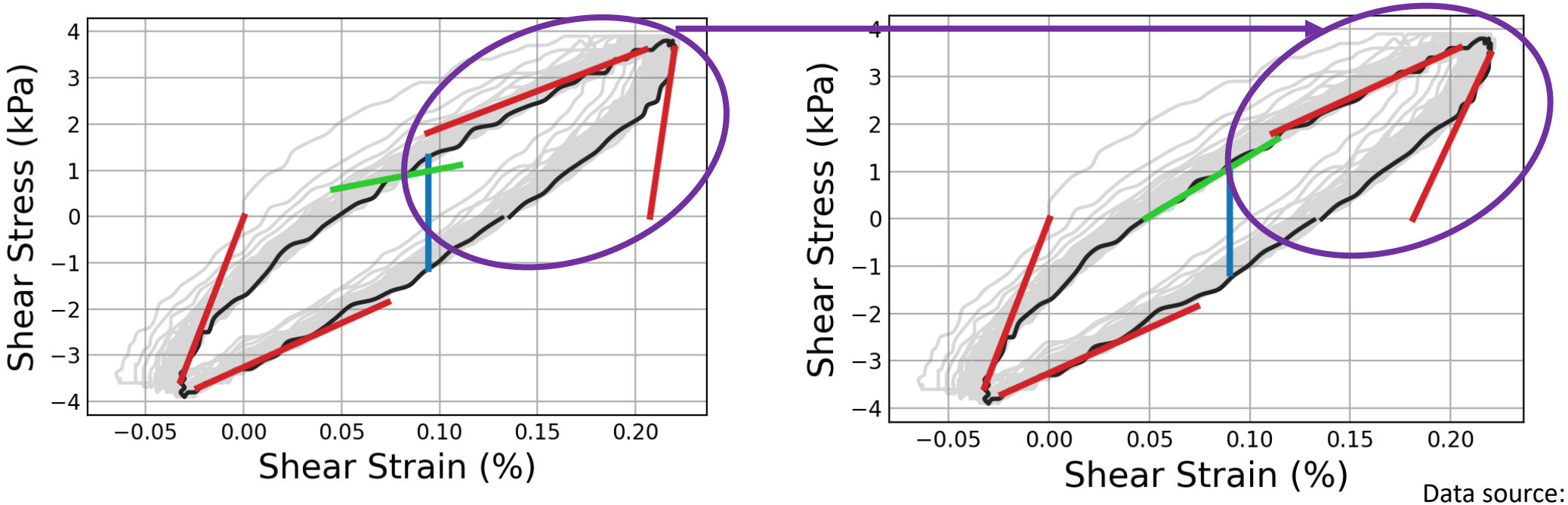
Reads data files, generates relevant plots

Compute metrics (with modifications)



User interaction with visualization tool



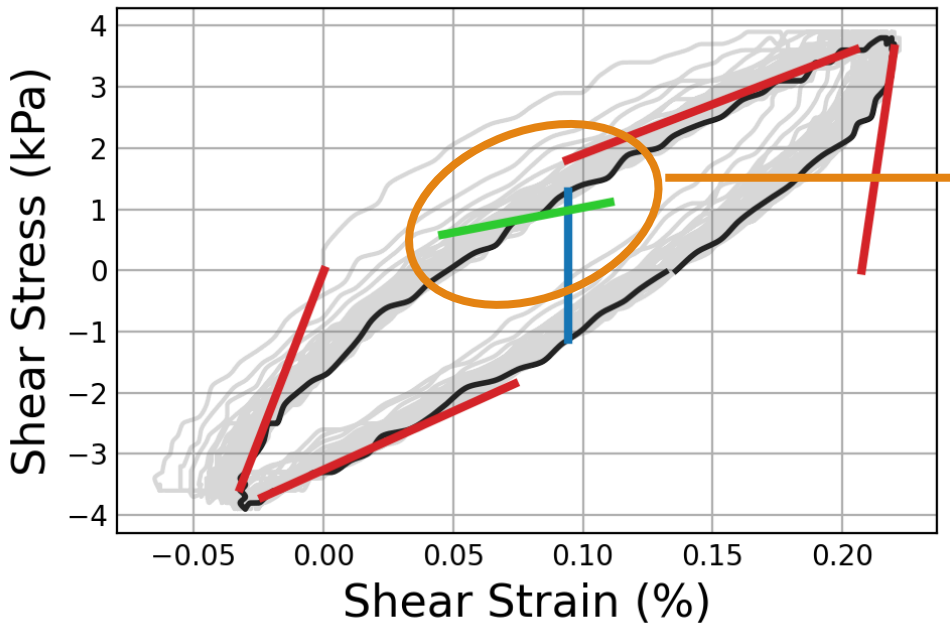


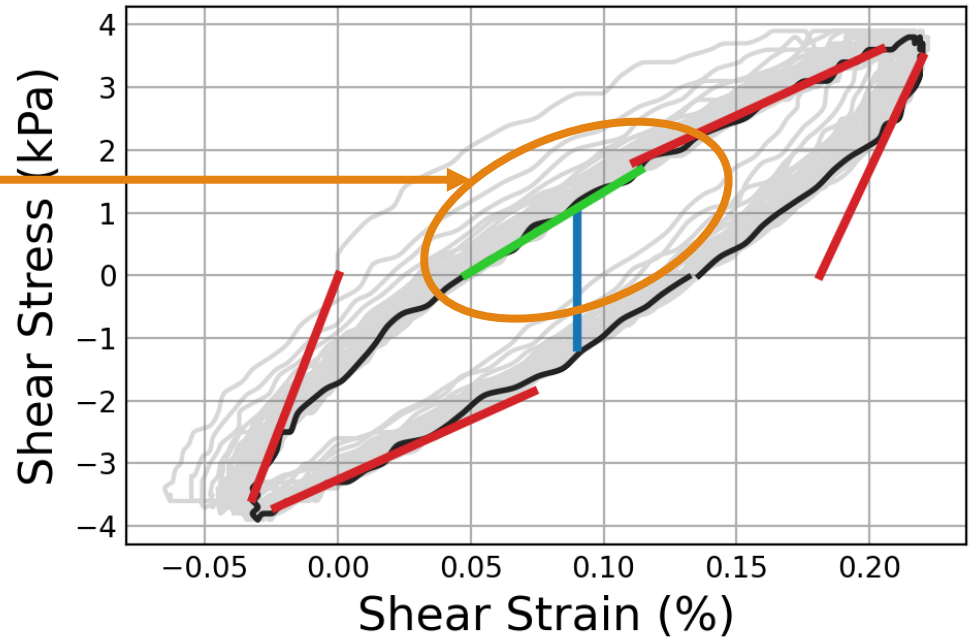
Upper Angle Initial = 0.13°

Upper Angle Final = 0.09°

Data source: Stuedlein et al. (2023b)

User interaction with visualization tool





Initial Minimum Modulus = 8.67 kPa

Initial Minimum Modulus = 25.53 kPa

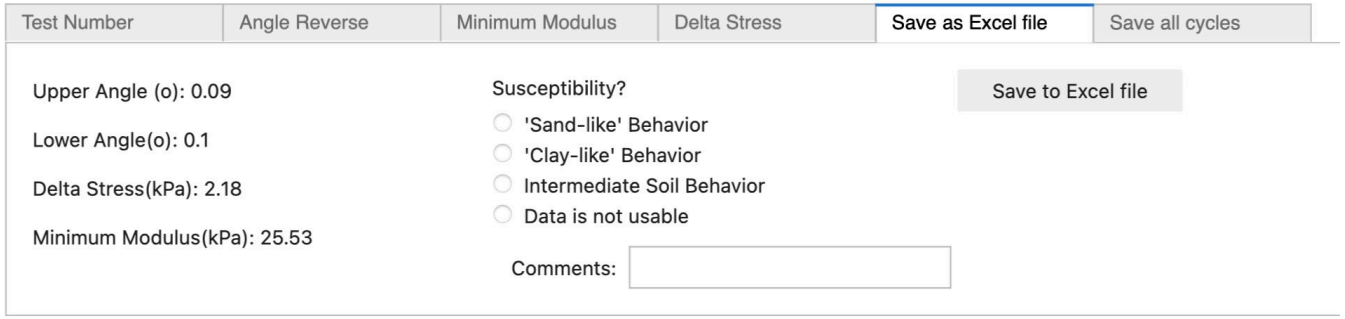
Data source: Stuedlein et al. (2023b)

Data Visualization

Jupyter notebook - interacts with NGL database (beta)

Reads data files, generates relevant plots

Compute modified metrics



Application:

- Multiple investigators view data
- Judge susceptibility using tools
- In this way, we assess material behavior for each cyclic test

References

Beyzaei, C.Z. (2017). "Fine-grained soil liquefaction effects in Christchurch, New Zealand*", PhD dissertation*, University of California, Berkeley. https://escholarship.org/uc/item/0s06z6gh#main

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Kramer, S.L., & Stewart, J.P. (2024). Geotechnical Earthquake Engineering (2nd ed.). CRC Press. https://doi.org/10.1201/9781003512011

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