

---

# Laboratory Component of Next- Generation Liquefaction Database

Kenneth S. Hudson, Paolo Zimmaro, Kristin Ulmer, Brian Carlton,  
Armin Stuedlein, Ali Dadashiserej, Scott J. Brandenberg, John  
Stomatakos, Steven L. Kramer, and Jonathan P. Stewart,

# Project Motivation

---

- **Assessment of liquefaction triggering is largely based on field observations, but certain aspects of behavior cannot easily be determined from field measurements.**
  - Susceptibility: Is a soil that did not liquefy not-susceptible to liquefaction? Or is it susceptible, and was not shaken strongly enough?
  - High overburden pressure: Deep soils may liquefy but not exhibit surface evidence that can be documented during post-earthquake reconnaissance.
- **Laboratory tests provide a supplement to field observations to make these determinations.**
- **There is currently no community-accessible database of soil laboratory test data. This project will make strides toward solving that problem.**

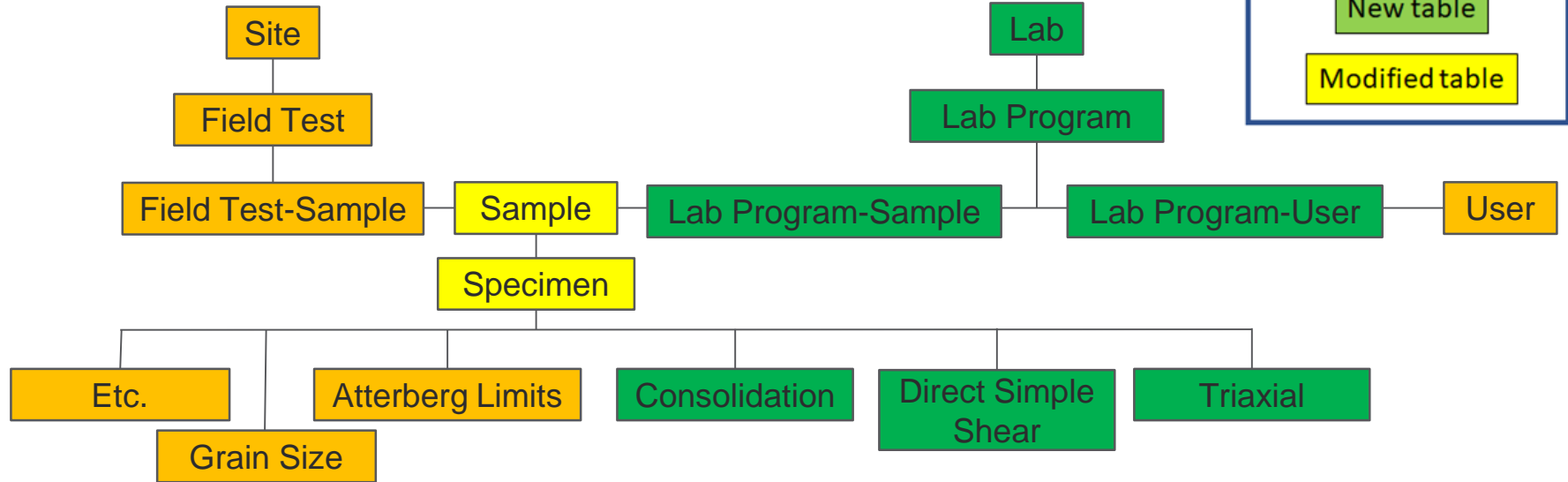
# Project Update

---

- **Laboratory Database**
  - We have developed and implemented a schema for laboratory testing as part of the Next Generation Liquefaction project.
  - New data types that can be added include direct simple shear, triaxial compression, and consolidation.
  - Samples may come from a field investigation or from a laboratory.
  - We have populated the database with direct simple shear and triaxial tests.

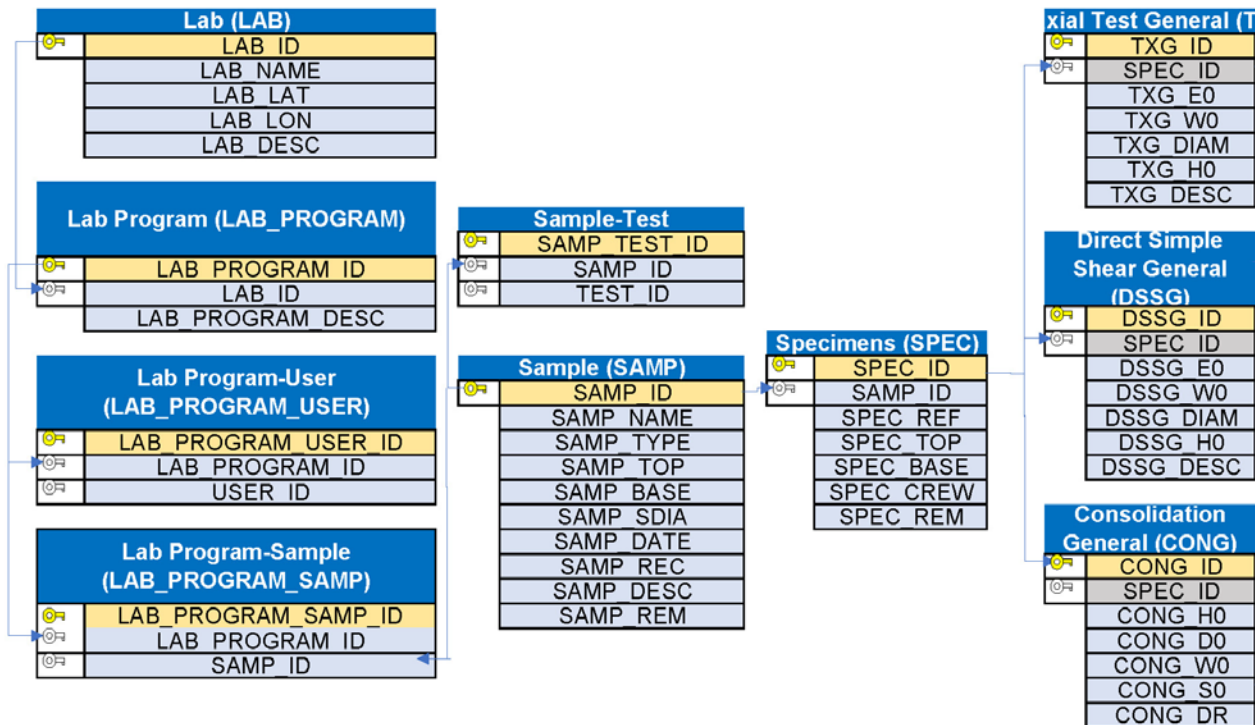
# Laboratory Test Database: Schema

- Laboratory Database
  - Integration with current NGL database schema



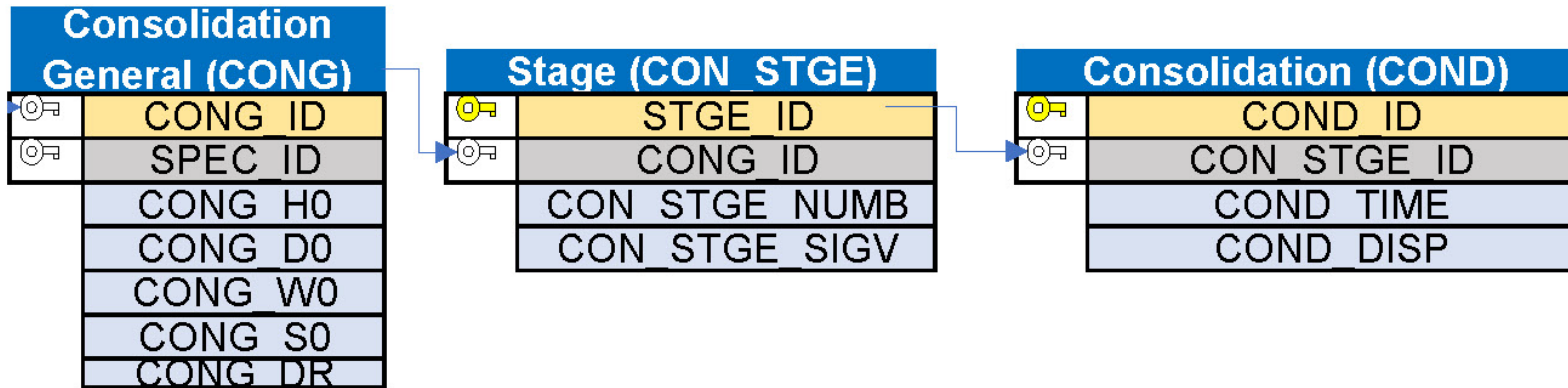
# Laboratory Test Database: Schema

- General tables (Test, Laboratory, Sample, and Specimen)



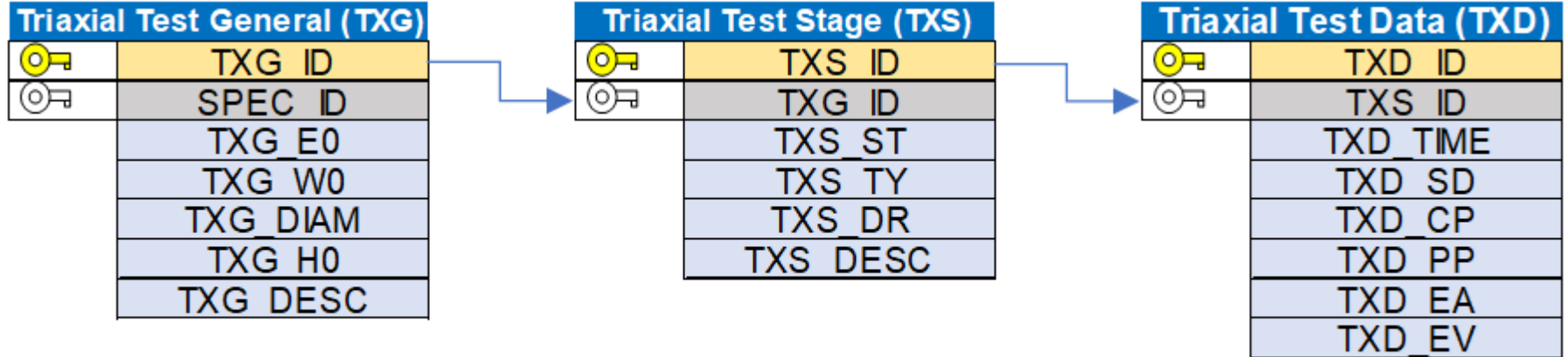
# Laboratory Test Database: Schema

- Consolidation test tables



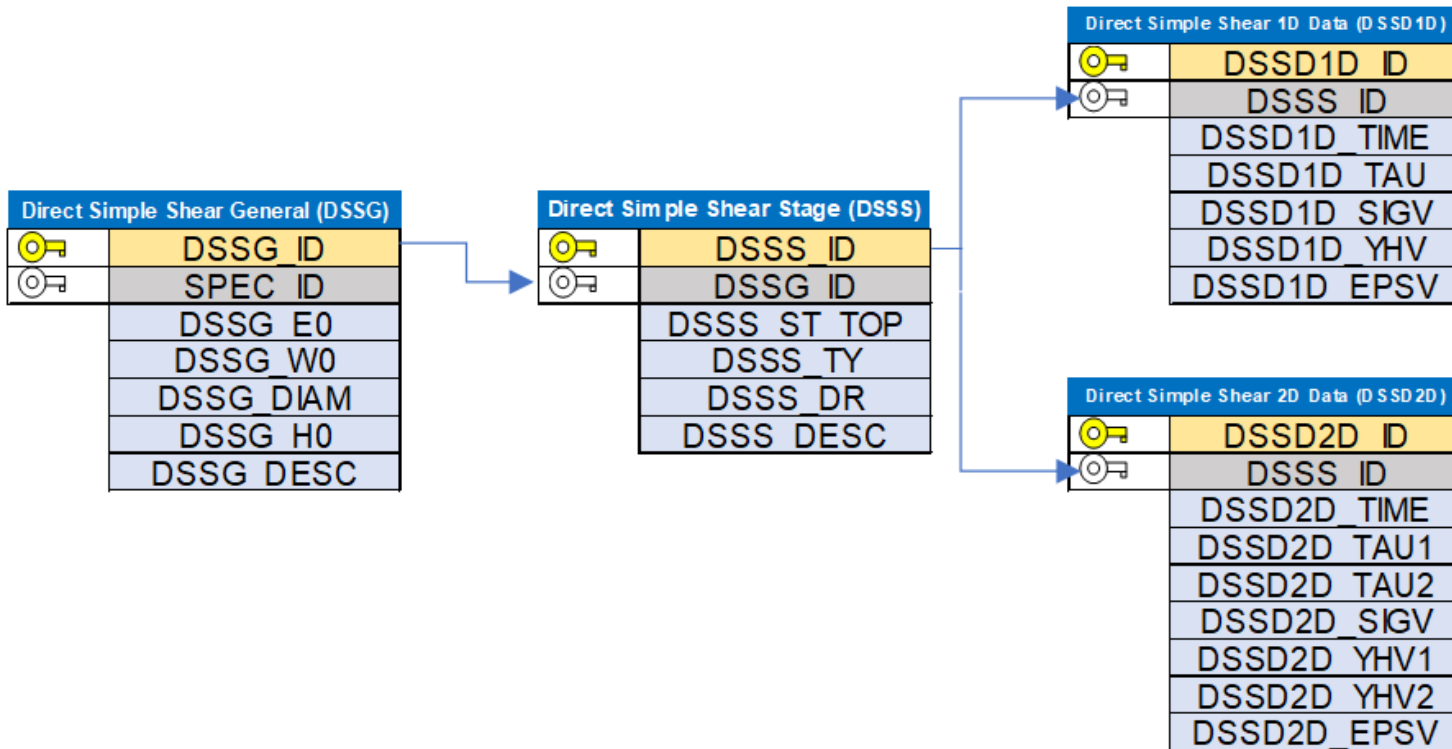
# Laboratory Test Database: Schema

- Triaxial test tables



# Laboratory Test Database: Schema

- Direct simple shear test tables





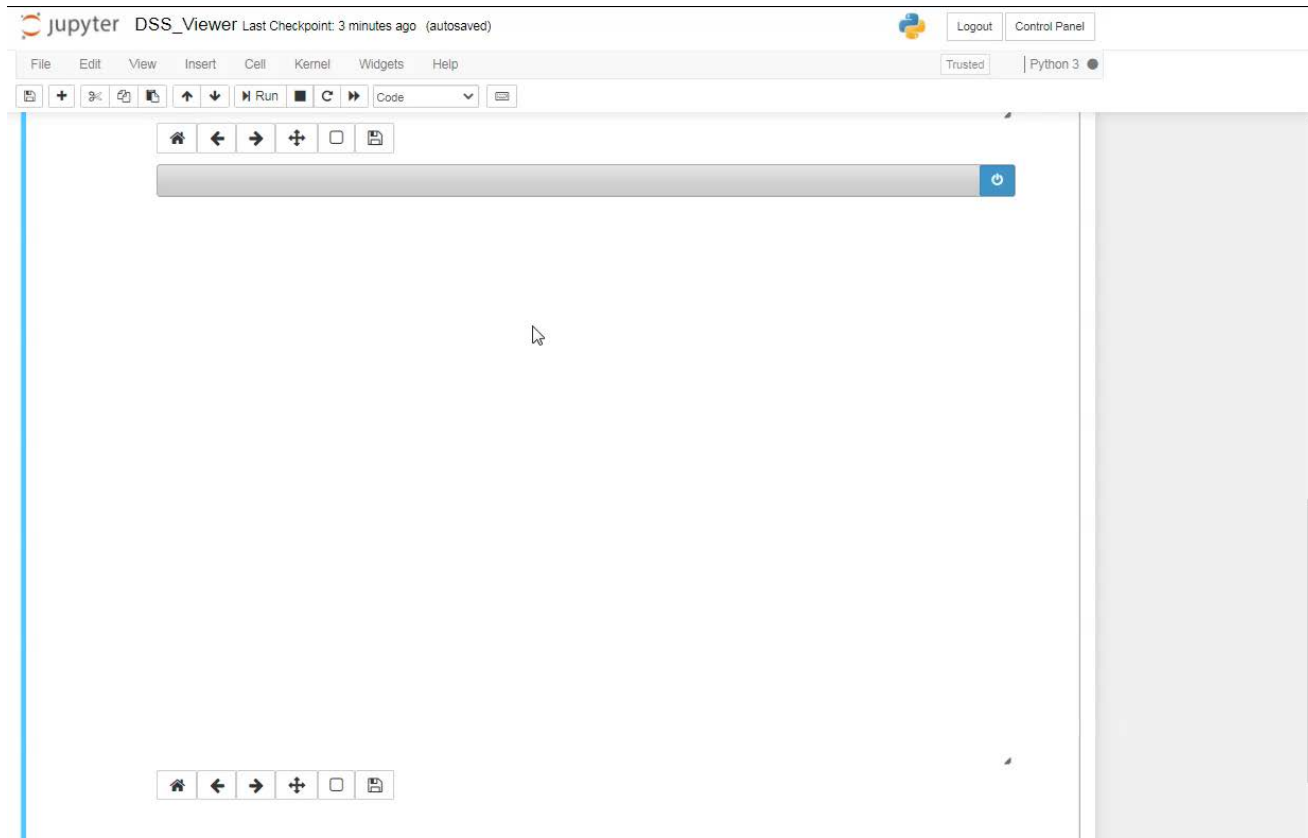
# Laboratory Test Database: Data Entry

- Data entry is done in MySQL Workbench for entering metadata and jupyter notebooks for entering time series or through the NGL website interface

Tests	Total
Index (specific gravity, water content, and/or percent passing number 200 sieve)	3847
Relative Density	77
Plasticity (Atterberg limits)	1385
Gradation	4495
Direct Simple Shear	53
Triaxial	63
Consolidation	4

ID	Lab Program Description
1	Testing of samples from sites associated with the Canterbury Earthquake Sequence (Beyzaei, 2017)
2	Cyclic and monotonic direct simple shear on Orange Co. Silica Sand (Eslami, 2017)
3	Testing on samples from Mihama Ward associated with 2011 Tohoku earthquake (Kwak et al., 2018)
4	Lab testing associated with (Shengcong and Tatsuoka, 1983; Cetin et al., 2018)
5	Lab testing associated with Graded area east of New River at SW edge of Brawley
6	Lab testing associated with 1979-1981 with CPT retesting in 2003 (Moss et al., 2005)
7	Cyclic testing on clay-silt blends (Eslami, 2017)
8	Testing of remolded samples from Mihama Ward

# Interacting With Test Data



The image shows a JupyterLab interface. At the top, the text "jupyter DSS\_Viewer Last Checkpoint: 3 minutes ago (autosaved)" is displayed. To the right of this text are buttons for "Logout" and "Control Panel". Below this is a menu bar with "File", "Edit", "View", "Insert", "Cell", "Kernel", "Widgets", and "Help". To the right of the menu bar are "Trusted" and "Python 3" indicators. Below the menu bar is a toolbar with icons for file operations (new, open, save, refresh, undo, redo), a "Run" button, a "Code" dropdown menu, and a "Code" button. The main area is a code editor with a toolbar at the top containing icons for home, back, forward, zoom in, zoom out, and refresh. A mouse cursor is visible in the center of the editor. At the bottom of the editor, there is another toolbar with the same icons as the top one.

# Interacting With Test Data

---

- **Examples: exploring liquefaction susceptibility metrics in lab data**
  - drainage effects ( $K_d$ ), partial saturation, path correction ( $K_p$ ), 2-dimensional loading ( $K_{2D}$ ), initial effective stress ( $K_\sigma$ ), initial static shear stress ( $K_d$ ), and susceptibility

# Interacting With Test Data

---

- **Examples: exploring liquefaction susceptibility metrics in lab data**
  - drainage effects ( $K_d$ ), partial saturation, path correction ( $K_p$ ), 2-dimensional loading ( $K_{2D}$ ), initial effective stress ( $K_\sigma$ ), initial static shear stress ( $K_d$ ), and susceptibility

OSU has led to the development of a significant laboratory dataset currently being added to the NGL database

- Includes tens of constant-rate-of-strain consolidation and constant-volume, mono-tonic direct simple shear (DSS) tests on soils from six sites, with the goal of establishing SHANSEP parameters suitable for the low and moderate plasticity silts
- The dataset also includes over 150 stress-controlled and tens of strain-controlled, constant-volume cyclic DSS tests most of which are accompanied with post-cyclic reconsolidation of monotonic shearing phases

# Interacting With Test Data

---

- **Examples: exploring liquefaction susceptibility metrics in lab data**
  - drainage effects ( $K_d$ ), partial saturation, path correction ( $K_p$ ), 2-dimensional loading ( $K_{2D}$ ), **initial effective stress ( $K_\sigma$ )**, **initial static shear stress ( $K_\sigma$ )**, and susceptibility

Kristin Ulmer and Brian Carlton have been conducting an ongoing study investigating the effects of  $\sigma'_c$  and  $\tau_s$  on liquefaction triggering

Ulmer K, Carlton B. Review of available data on the effects of confining pressure and initial static shear stress for use in liquefaction triggering analyses. *Proceedings of the 12th National Conference in Earthquake Engineering*, Earthquake Engineering Research Institute, Salt Lake City, UT. (2022)

# Start interacting with the database now!

<https://nextgenerationliquefaction.org>



This screenshot shows the main interactive interface of the website. On the left, there is a search and filter panel with a 'Type event name' input field, 'Magnitude' filters for 'min' and 'max', and a '(choose one or typ)' dropdown menu. Below these are 'Submit' and 'Reset' buttons. A 'Statistics' dropdown is at the bottom left. The central part of the interface is a world map with various data points represented by red and white buoys and grey circular markers. Some points are labeled with numbers like 11, 14, 19, 21, 22, and 23. The map includes zoom controls (+ and -) in the top left and a scale bar (3000 km / 2000 mi) in the bottom left. On the right side of the map, there is a vertical legend with icons for different event types and filters, including 'To', 'Im', 'Te', 'Even', 'Gene', 'S', 'E', 'C', 'T', 'N', 'It', and 'v'.

