San Jose State University Interdisciplinary Science Building

Overview

Construction of the Interdisciplinary Science Building on the San Jose State University campus is the first stage in the development of a state-of-the-art Science and Innovation Complex. The 8-story, 157,400 sq. ft. structure is the College of Science's first new building in almost 50 years. It will feature teaching, research labs for biology, chemistry departments, instructional areas, conference rooms, high-performance computing areas, and collaborative hubs where students and faculty members can work together. The building is scheduled to open in January 2022 to the SJSU Spartans. It will be the fourth science building, along with Science Building (1957), Macquarie Hall (1965), and Duncan Hall (1972).

Photo: Architectural image of SJSU ISB.

Geotechnical Conditions and the Challenges

The site is located on the south side of San Francisco Bay, a seismically active region. The geotechnical investigation revealed subsurface conditions generally consisting of soft to stiff lean clay (CL), with a 10-ft layer of very loose silty sand (SM) present at approximately 19 ft below the existing grade. Groundwater was also observed at a shallow depth, between 12 and 18 ft below grade.

The geotechnical engineer's analyses indicated the granular soil layer had the potential to liquefy during a seismic event. Due to the site being in a seismically active area; the potential for strong ground motion is considered significant during the design life of the structure. The static settlement was also a concern due to the soft ground conditions where column and wall loads for the new building were moderate to high due to the height of the building.

The project also required an excavation up to 15 ft below the existing grade for installation of utilities and construction of the basement level and foundation. The stability of the excavation was a concern, especially where the excavation extended below groundwater.

Lastly, during the clearing and grubbing process for the site preparation, the discovery of contaminated soil required excavation and removal prior to any foundation work. With the construction starting in July 2019 and the building slated to open in January 2022, the project could not afford any setbacks or delays.

The Solution – Keller Ingenuity

Installation of cast-in-place pile foundation up to 90 ft below grade was recommended from the initial geotechnical investigation. However, the installation cost would have been immense, the project was open to other value engineering options.

The second ground improvement method specified to alleviate liquefaction and static settlement concerns was stone columns, or vibro replacement. However, the soft soils were unlikely to provide adequate confinement to prevent bulging of the stone columns.

Therefore, Keller offered an alternative deep soil mixing (DSM) solution meeting the project requirements of:

- an allowable footing bearing pressure of 4000 psf
- the allowable total combined seismic and long-term static settlement of 2.0 in.
- allowable static and seismic differential settlement of 1.0 in. over a 40 ft span.

*Photo: Predrill, Soil Mixing Equipment, loader, Forklift, Silos and on-site batching.
Concrete pump truck on the right – for foundation work, not related DSM*

Deep soil mixing is a soil improvement technique used to strengthen soil in situ accomplished by blending the in situ soil with cement slurry. As the mixing tool is advanced into the soil, grout slurry is pumped through the hollow stem of the shaft and injected into the soil at the tip and throughout the tool. The auger flights and mixing blades on the tool blend the soil with grout in a pugmill fashion. Once the design depth is reached, the tool is withdrawn to the surface, and left behind are stabilized soil mixed columns. DSM columns increase the soil matrix stiffness to create a block of improved soil to support building loads under both static and seismic conditions.

A total of 325 DSM columns were installed throughout the building footprint to depths of between 26 and 31 ft. By installing the soil mixing columns in an interlocking cellular grid, they functioned as intermediate foundation elements to transfer building loads to more competent bearing strata and controlled potential settlement and liquefaction hazards of the subsurface soil. As a low-permeable element installed in an interlocking fashion, the DSM successfully provided water cut off for the excavation of basement level and foundation elements. For the water tank and elevator pit's deeper excavation, Keller's innovated solution was successful again, installing W18 x 35 structural beams in the wet soil mix columns as temporary bracing.

Photo: Visual representation of interlocking cellular grid soil mixed column shown after excavation.
Easy to spot as the DSM is a low permeable element

During construction, Keller's state-of-the-art DAQ systems allowed our clients and our engineers to see the engineering parameters of each mixed element completed via hard copy printout. These computer systems allowed Keller to control the mixing process including the binder content and the energy of mixing required within the target formation.

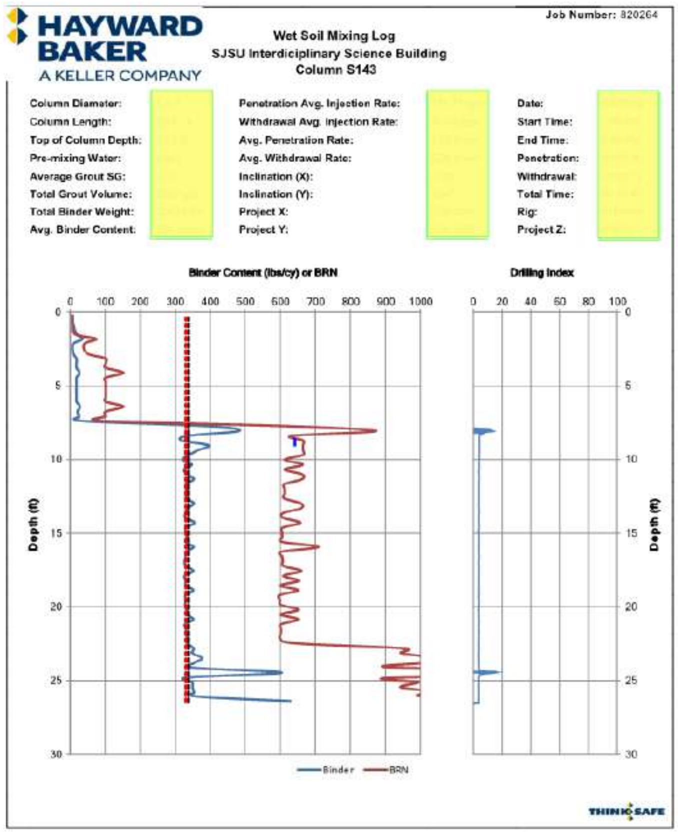

Photo: Keller's Real-time Data Acquisition Report

To ensure column integrity and performance, Keller submitted a QA/QC program including wet-grab samples taken at a frequency of one column per shift with 8 specimens to be unconfined compressive strength tested at 7 days, 14 days, and 56 days, with additional testing if needed. Once construction was near complete, product verification was performed through coring full-length columns randomly selected by the Geotechnical Engineer to also be unconfined compressive tested. All core samples resulted in a recovery of approximately 98% with a compressive strength averaging 440 psi. All daily wet grab samples resulted in a compressive strength averaging 340 psi. The project required strength was 150 psi.

Photo: Sample Core Run, column S101 run 5

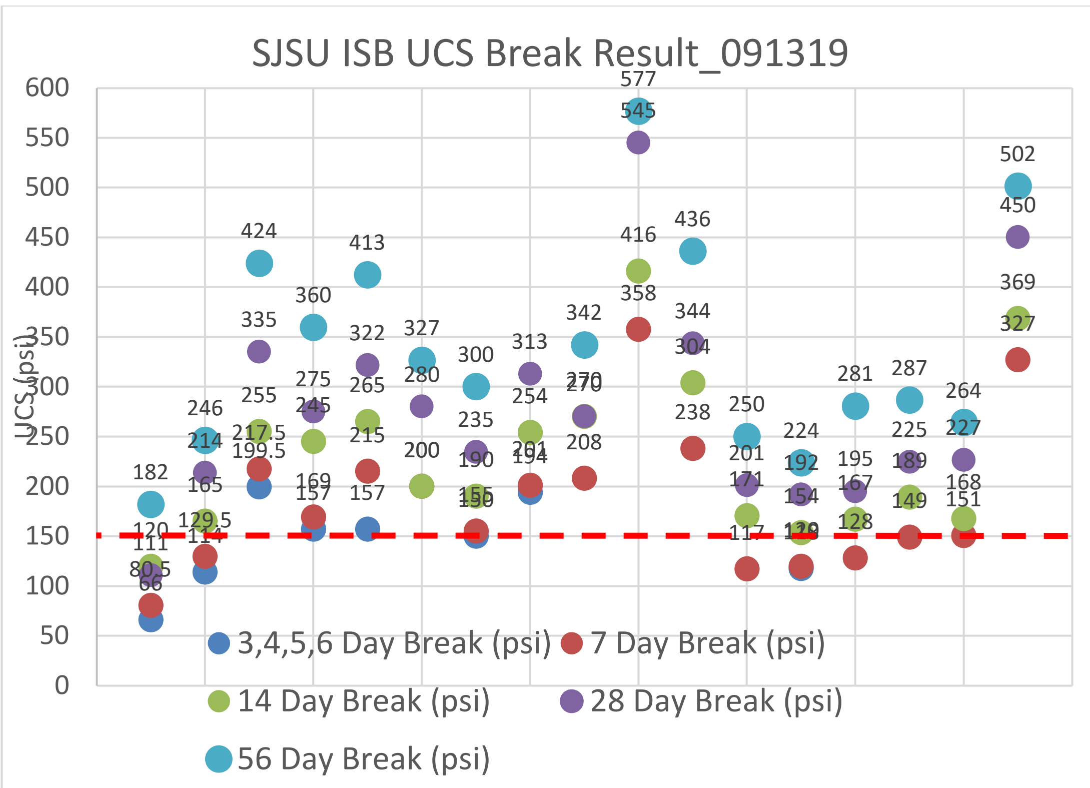

Figure: UCS Break Summary of Daily Wet Grab Samples

In close cooperation with Keller's project team and field crew, Keller was able to develop an optimal work plan and equipment sequence on a tight working area. Keller field crew meticulously planned out daily installation sequences where predrill and soil mixing rigs worked in tandem.

With Keller's efficiency and QA/QC verification tests resulting in values that are greater than the project requirement, Keller was able to turn over half the site for the GC to fast-track the project.

Even with the tighter work area and additional columns from re-design of the electrical equipment pads, Keller was able to complete the project 19 days ahead of schedule.

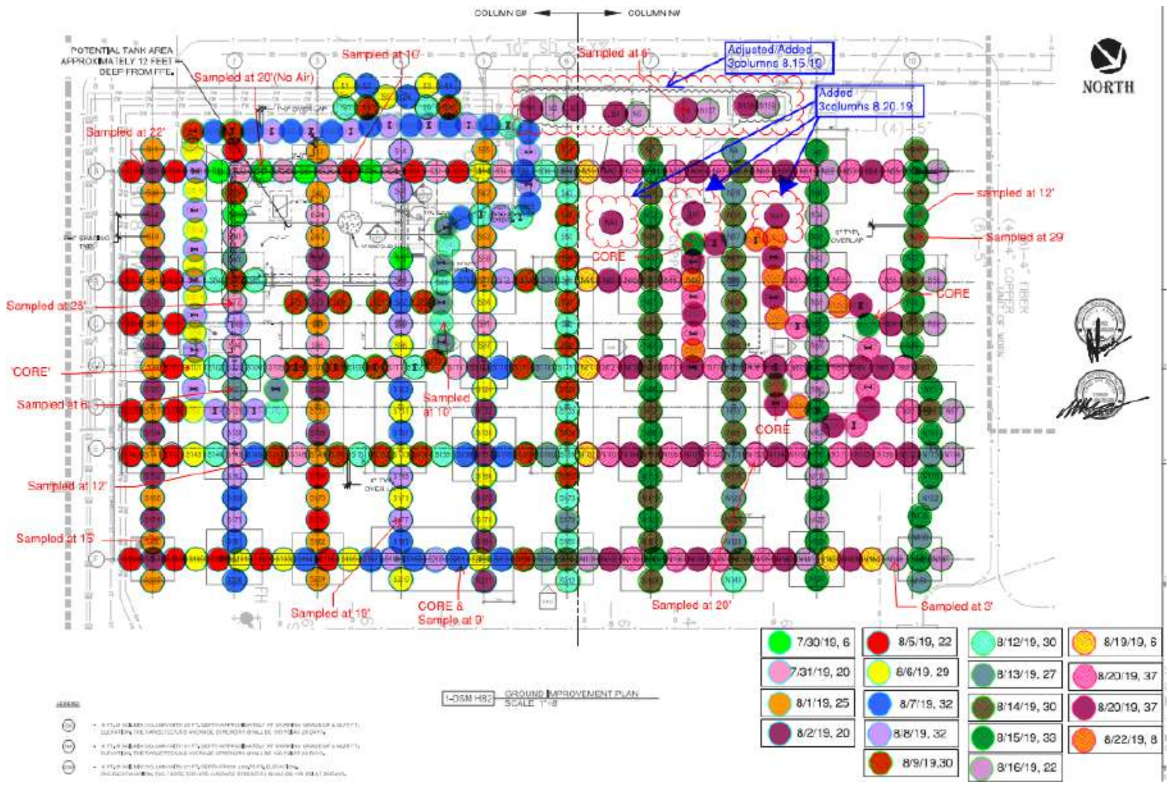

Photo: Color Coded Production Tracking Map

Photo: Foundation Pour After DSM Installation