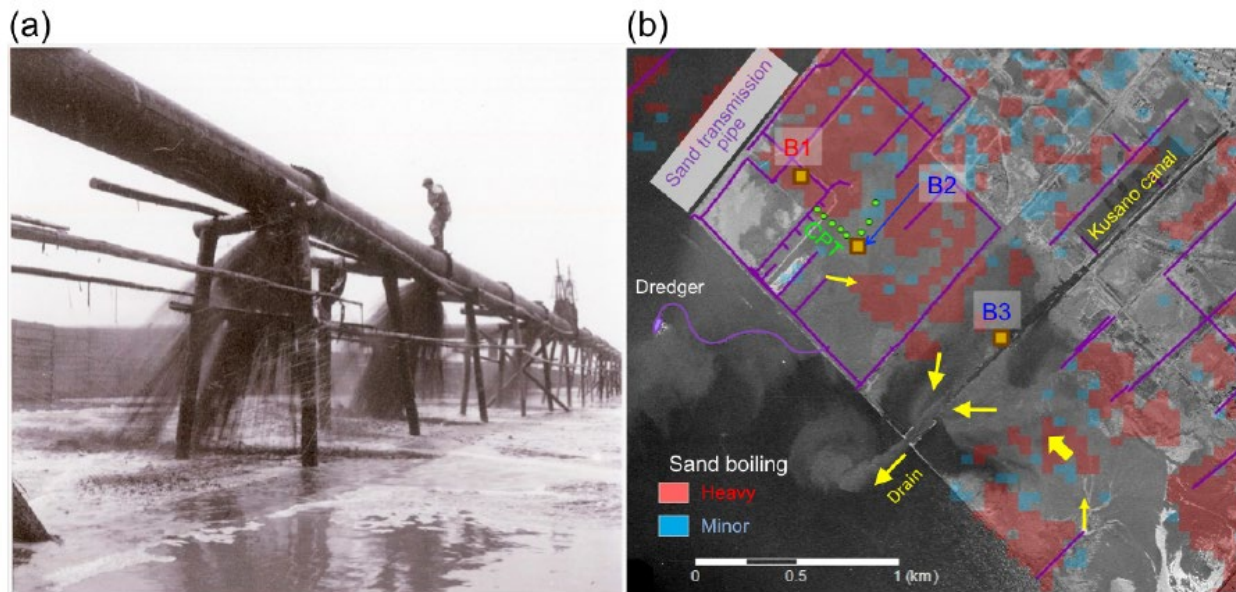


PEER “Research Nuggets”

Title: Ground failure in hydraulic fills in Chiba, Japan and data archival in community database

Authors: Scott J. Brandenberg, Jonathan P. Stewart, Kenneth S. Hudson, Dong Youp Kwak, Paolo Zimmaro, Quin Parker

Motivation: The district referred to as Mihama Ward is on ground composed of hydraulic fill sluiced in by pipes, thereby resulting in a gradient of soil coarseness, with coarser soils deposited near the pipes and fine-grained soils carried further away. Observations from local researchers at Chiba University following the 2011 Tohoku Earthquake indicate that ground failure was observed closer to the locations where the pipes deposited the soil, and not further away. This ground failure consisted of extensive sand boiling and ground cracking, which led to building settlement and pipe breaks. Our hypothesis at the outset of the project was that liquefaction susceptibility might explain the pattern of ground failure. Specifically, soils deposited near the pipes are susceptible due to their coarser texture, while soils further from the pipes may be non-susceptible due to the presence of clay minerals and higher plasticity. Were this hypothesis borne out by evidence, soil in the transition zone would have provided important insights about liquefaction susceptibility. Another important motivation for some of the tasks in the study is that a key consideration in susceptibility studies is the relative scarcity of laboratory data that is publicly available in an accessible format.



Reclamation process for Mihama ward during the 1970's showing (a) discharge pipes used to place dredged soil, and (b) an aerial view of the discharge pipe locations (Nakai and Sekiguchi 2013).

Objectives: Our objectives are to study geotechnical site investigation data at Mihama Ward to ascertain the causes of ground failure, and whether susceptibility can explain the observed damage patterns. Available data includes geotechnical site investigations consisting of boring logs and cone penetration tests, laboratory tests performed on undisturbed samples by Tokyo

Soils, and laboratory tests performed on disturbed samples at UCLA. Furthermore, our objective is to expand the Next Generation Liquefaction database to include the laboratory test results from Mihama Ward.

Methodology: The Mihama Ward case history involved laboratory tests performed by Tokyo Soil Research Co. Ltd. and the UCLA geotechnical laboratory. Given the importance of this data to the understanding of this case history, we recognized a need to incorporate laboratory tests in the NGL database alongside field tests and liquefaction observations. We therefore developed an organizational structure for laboratory tests, including direct simple shear, triaxial compression, and consolidation, and implemented the schema in the NGL database. We then uploaded data from tests performed by Tokyo Soil and UCLA into the NGL database. Furthermore, numerous other researchers have also uploaded laboratory test data for other sites. This report describes the organizational structure of the laboratory component of the database, and a tool for interacting with laboratory data.

Results: Our hypothesis that susceptibility was responsible for observed patterns of damage at Mihama Ward was only partially true. Zones that exhibited ground failure did indeed contain susceptible soils. Furthermore, some zones that did not exhibit ground failure in some cases consisted of non-susceptible soils. However, there were profiles between these two zones that did not exhibit ground failure, and consisted of non-plastic fine-grained soils that are considered susceptible to liquefaction. Liquefaction is predicted to trigger in these soils, yet manifestation was not observed. These cases are therefore false-positives with respect to existing triggering relationships. All laboratory test data contained in this report is publicly available through the NGL website.

Conclusions: We postulate that the lack of manifestation may arise from the level ground conditions and corresponding lack of static driving shear stresses in Mihama Ward, as well as the fine-grained soils being less erodible than sandier soils that produced surface evidence of liquefaction. We distinguish triggering (defined as the development of significant excess pore pressure) from manifestation (defined as observations of ground failure), and postulate that the susceptible fine-grained soils at Mihama Ward likely triggered but did not manifest.

Future directions/References: We anticipate that the NGL database will continue to grow as users contribute laboratory test data, and that it will be a valuable resource for assessing the susceptibility and cyclic-strength of fine-grained soils.

Keywords: Liquefaction, Tohoku Earthquake, Database, Laboratory, Triggering, Susceptibility