Evolution of Excavation Shoring: Where We Were, What's Possible

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Protective System Options

- Sloping – Inclined cutaway
- Benching – Vertical/horizontal planes
- Shoring – Active wall loading
- Shielding – Passive deflector

Basis for System Selection

- Dimensions necessary
- Soil type
- Adjacent area
- Work to be done

Earliest protective systems involved configuration of soil, timber

- 1950s – Development of aluminum hydraulic vertical shores
- 1970s – First manufacturer to commercially offer shields
- 1980s – Slide Rail systems imported to US from Europe
- 1990s – Expansion of large hydraulic bracing systems
- 2010s – Development of hybrid shield frame with sheeting

- What did the evolution of protective systems look like?

Extreme slope with vertically sided lower portion

Photo courtesy of Sewerhistory.org

Natural soil movement resulted in oversized excavations

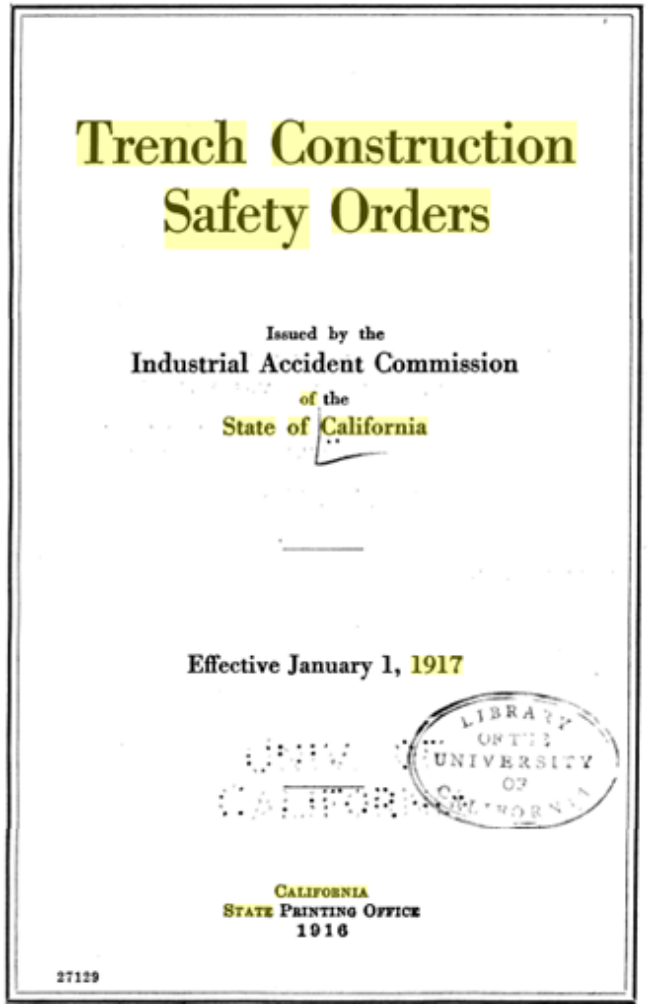
Photo courtesy of Sewerhistory.org

Challenges in understanding soil behavior

- Note timber at only the lowermost portion of the trench

Photo courtesy of Sewerhistory.org / National Clay Pipe Institute

Public Trench Safety Orders of January 1, 1917



Trench Construction Safety Orders

Issued by the
Industrial Accident Commission
of the
State of California

Effective January 1, 1917

CALIFORNIA
STATE PRINTING OFFICE
1916

27129

Order 1003. **Shoring and bracing.**

(*a*) The sides of all trenches in hard, compact material which are five (5) feet or more in depth and over eight (8) feet in length shall be securely held by shoring and bracing. If the unit tunnel method is used, the length of earth left in place between the separate unit trenches shall be not less than one-half the depth of the trench, and shall be considered as taking the place of shoring and bracing.

(*b*) All trenches of over eight (8) feet in length and five (5) feet or more in depth in hard, compact material shall be braced at intervals not exceeding eight (8) feet with two (2) inch by six (6) inch planks, or heavier material, placed vertically in the trench opposite each other against the walls. These braces shall, if possible, extend to the bottom of the trench; otherwise as low as possible to clear the top of pipe, sewer, conduit or other material to be placed in the bottom of the trench.

(*c*) The braces in trenches shall be supported by screw jacks or by timbers placed normal to both braces, cleated and rigidly screwed or wedged. The timbers shall be not less than those given in the following table:

Width of trench.	*Size of timbers.*
1 ft.–3 ft. incl.	4 x 4 inches
3 ft.–6 ft. incl.	4 x 6 inches
6 ft.–8 ft. incl.	6 x 6 inches

(*d*) The number of horizontal strut braces, either screw jacks or timbers, required for each pair of vertical braces shall be determined by the number of zones of four (4) feet each into which the depth of trench may be divided. One horizontal brace shall be required for each of these zones. Trenches, the depth of which can not be divided equally into these standard zones, shall have an extra horizontal brace supplied for the short remaining zone if such zone is greater in length than one-half the four (4) foot unit. In no case, however, shall horizontal braces be spaced greater than five (5) feet center to center.

(*e*) The bracing and shoring of trenches must be carried along with the excavation, and must in no case be omitted

Timber

- Readily available materials
- 8’ horizontal spacing in a 10’ deep trench (OSHA C-2.3)
- Limits constructability

Industry, owners pushed need for mechanical systems

- Increased spans
- Deeper excavations
- Faster installations
- The challenges:
  - Congested urban settings
  - Surcharge loads
  - Hydrostatic pressures

Failure of Temporary Works Resulted From Casual Approach

Over 50% of construction accidents

- Lack of understanding temporary construction loads
  - Transient equipment, stored materials
- Underestimated impact of surcharges
  - HS20-44, Cooper E-80
- Failure to consider environmental issues
  - Weather, vibration, moisture content in soil

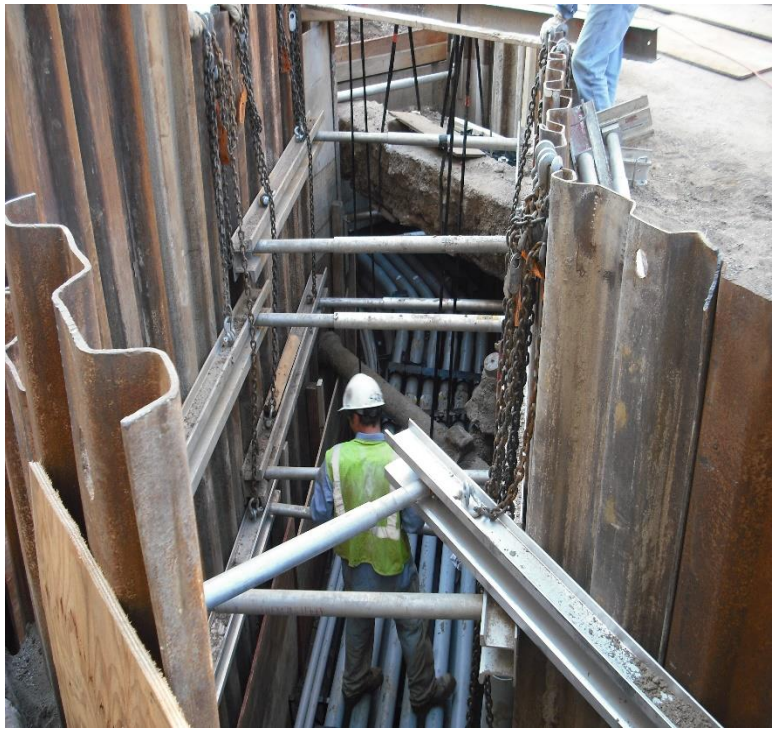
Vertical Shores

- Early 1950s
- Alternative to timber
- Innovative
  - Non-Entry installation
  - Non-Entry removal
- Actively loads trench wall
- Required close spacing

Vertical Hydraulic Shores

Horizontal Spacing of 4’ to 6’

Walers



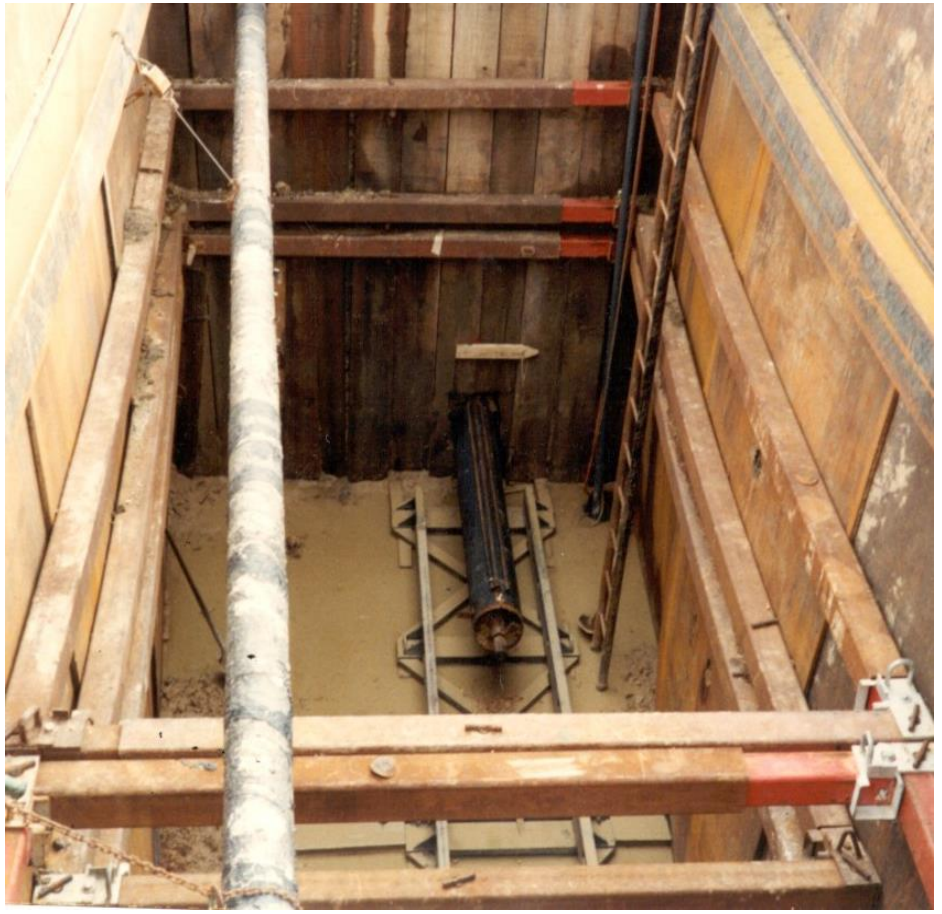
Walers for greater span

End Shores

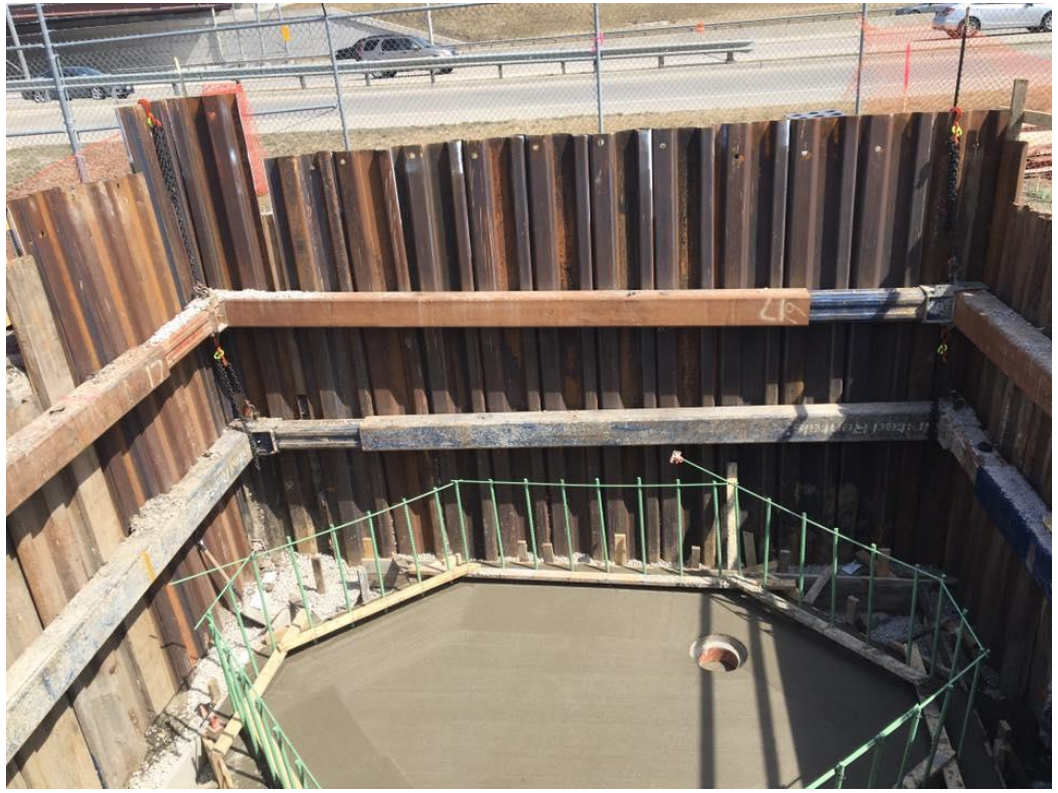
Developed for end protection

6” Manhole Brace

8” Manhole Brace



10” Manhole Brace



Shore Brace

Shoring Shields

- Static or Hydraulic
- Stackable in static mode
- Steel telescoping over-sleeves
- Deeper in hydraulic mode

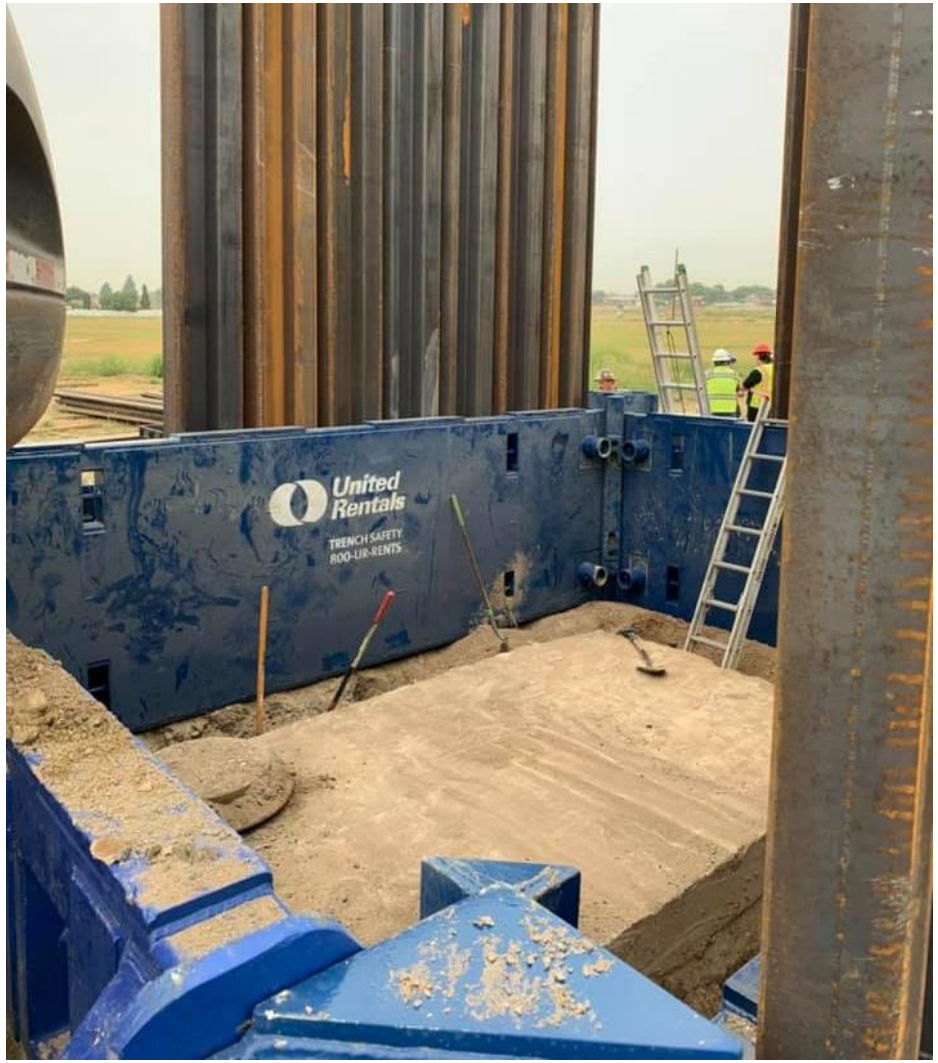
Steel Trench Shields

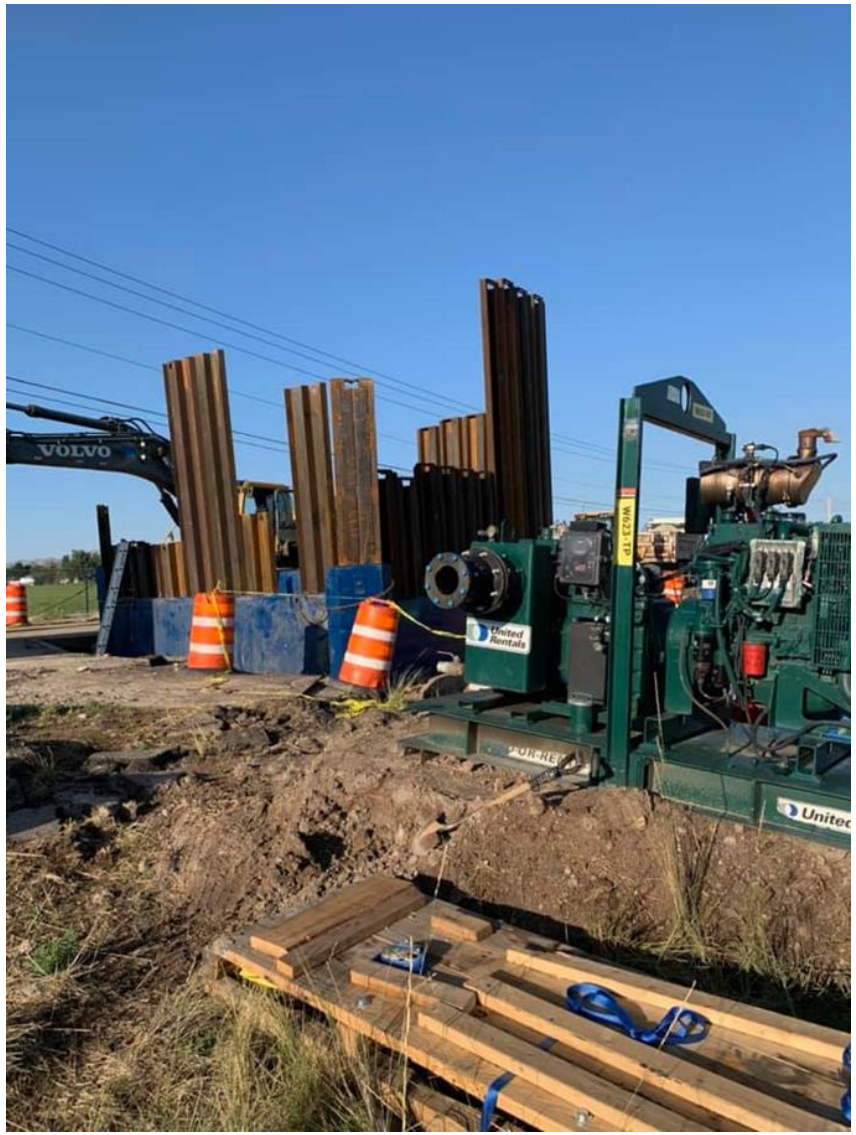
End-Loading Spreaders

Slide Rail Pit

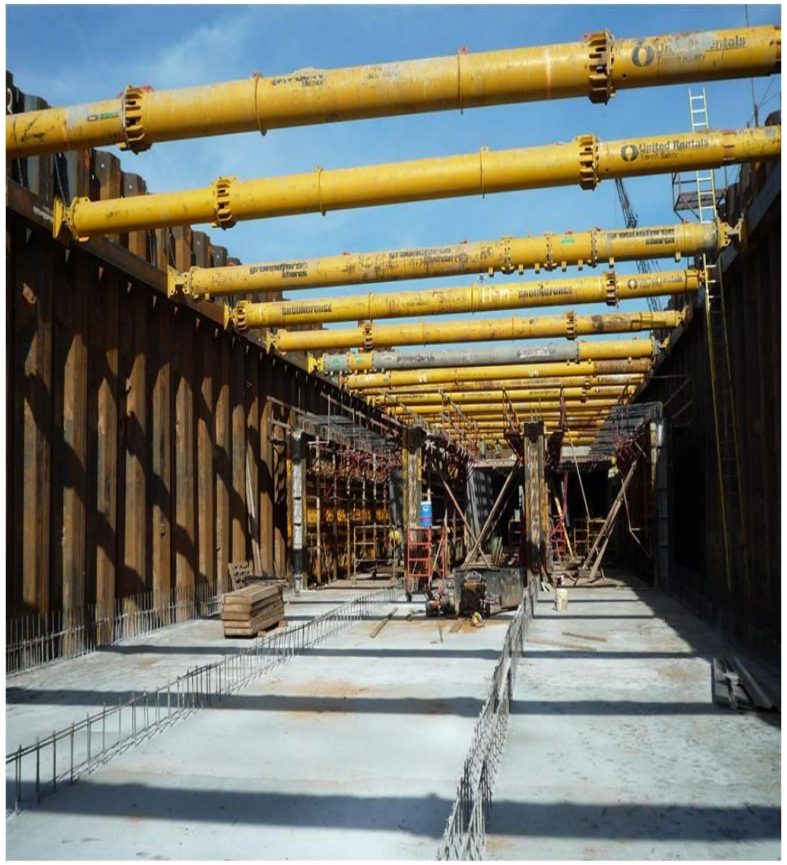
Linear Slide Rail

G3 Hybrid Sheeting Guide

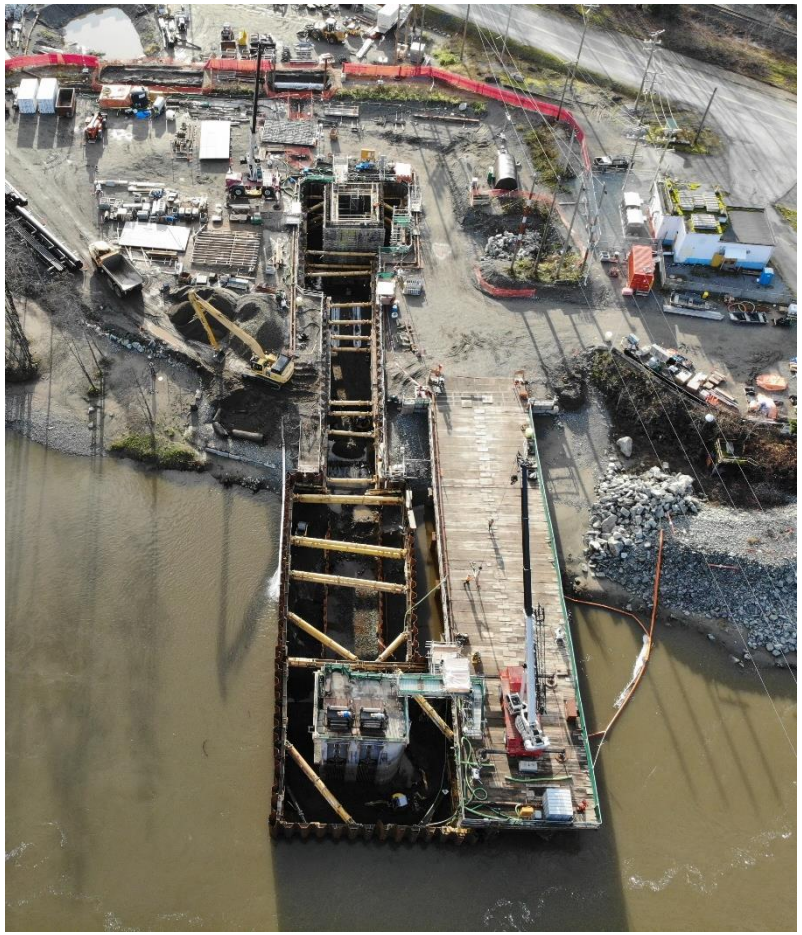




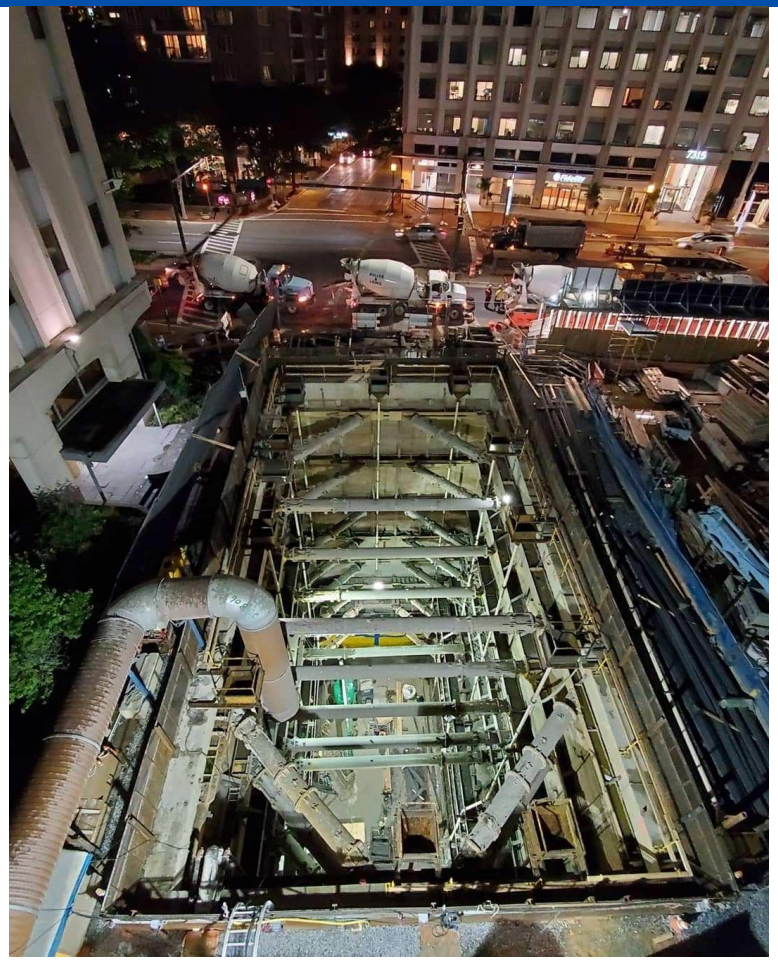
Oklahoma Culvert

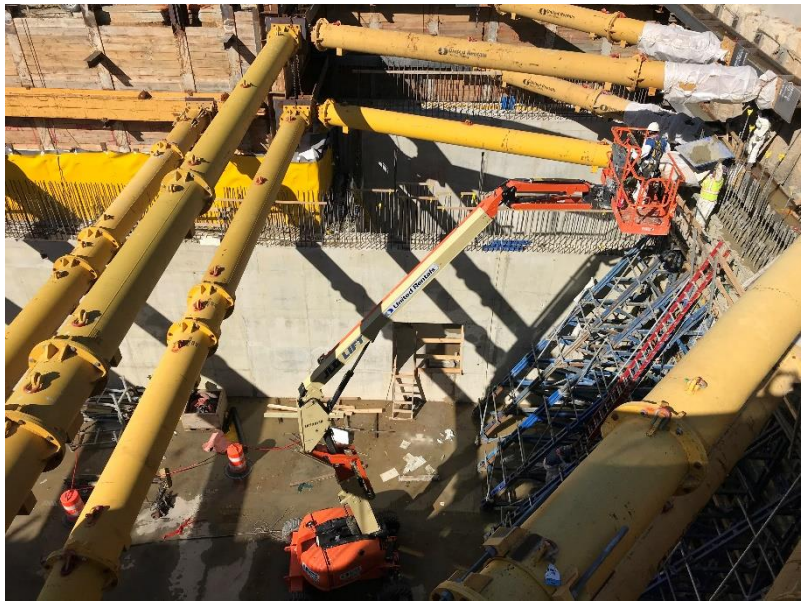


Kittimat Cofferdam



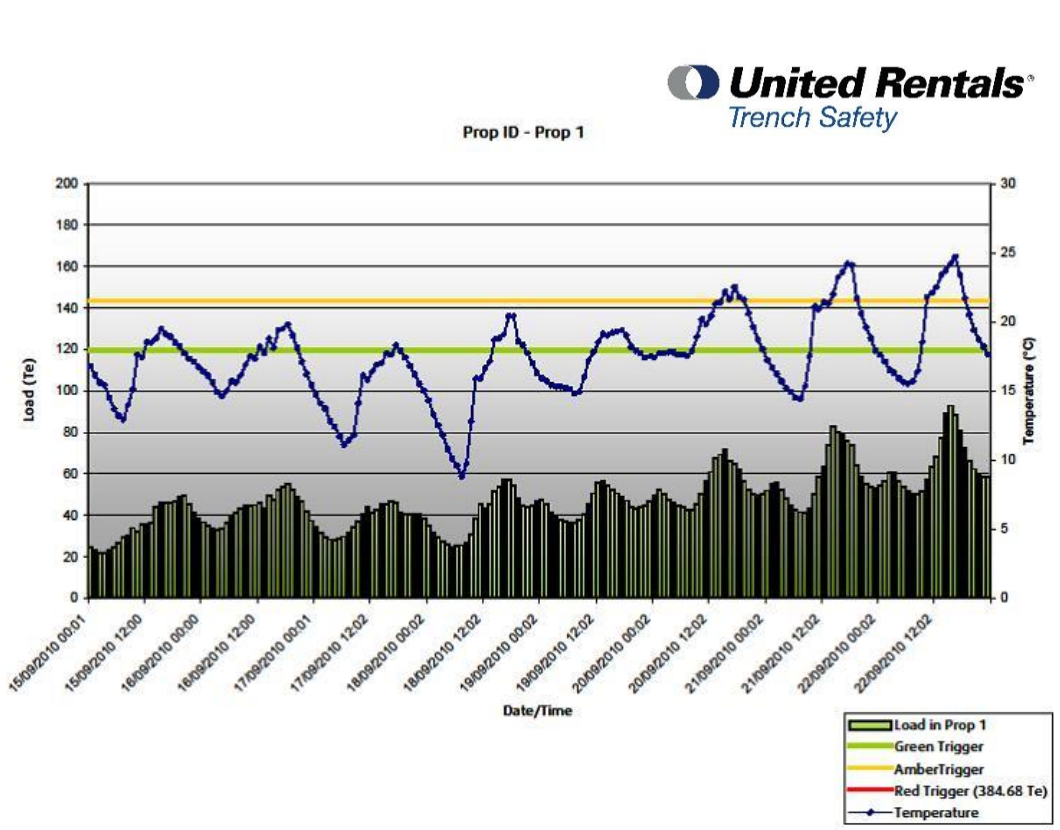
Purple Line Transit Rail

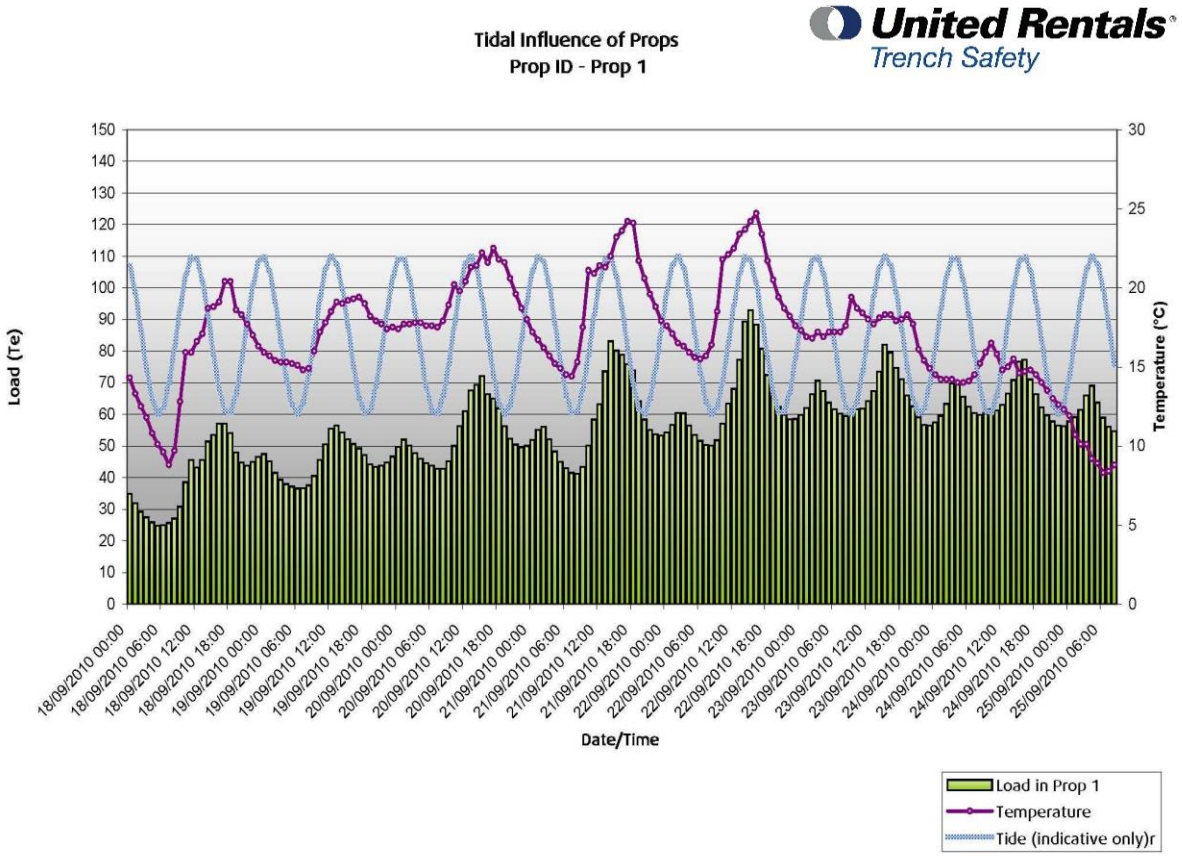




Wireless Load Monitoring - Data Gathering for Stability of Adjacent Structures

Wireless Load Monitoring Reporting





What's next?

Wherever your clients ask you to go, you can count on us to help you get there. Innovations have helped us get this far - let us help develop the new unheard of thing.