Example 2 (1959) - Braced sheet piled excavation in soft clay

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<th>CATEGORY</th>
<th>MAIN OBJECTIVE</th>
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<td>Construction control</td>
<td>Monitor safety of a difficult excavation</td>
<td>Reduced cost and construction time</td>
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BACKGROUND AND DESCRIPTION OF PROJECT
In 1959 an open cut excavation 30 m by 11 m and 11.5 m deep in soft clay was required to install compressed air locks needed to start driving a new subway tunnel in Oslo. The design depth of the required excavation exceeded the critical depth. Because of the large depth to bedrock at the site it was not feasible to improve the stability of the excavation by driving sheet piles to bedrock. Thus, a special construction procedure had to be used to allow excavation to full depth without causing a bottom heave failure.

To avoid a bottom heave failure the excavation was stabilized by flooding it with water before the final 5.7 m was excavated. The design called for 4 levels of bracing, one of which was to be installed underwater by divers, Figure 1.

FACTORS THAT INFLUENCED THE DESIGN OF THE MONITORING PROGRAM
In view of the complexity of this excavation and because of the need to verify that the design was safe and sound, an extensive monitoring program was justified. It was felt that instability of the excavation could be assessed primarily by careful study of ground movements and strut loads, providing these were measured frequently and accurately enough to be able to look at not only magnitudes but also rates of change in the data during critical stages of the work.

SCOPE OF INSTRUMENTATION
The primary instrumentation included 9 load cells, 18 settlement reference points, one heave gauge and two inclinometer casings to provide convenient and accurate measurements of strut loads and ground movements. Other instruments included 23 earth pressure cells, 8 pore pressure sensors on the sheet piles, and 19 piezometers in the natural ground. These provided supplementary information.

MOST SIGNIFICANT INFORMATION DERIVED
The stabilizing effect of the water on the excavation was clearly shown in the measured rates of settlement and the measured strut loads. As work continued, an analysis of the field measurements indicated that excavation could proceed to the final depth without installation of the fourth level of struts, and this was done.

- The field measurements confirmed adequate safety of the project while the work was in progress, and the work was completed without mishap.
- The measurement program contributed to a significant savings in time and money because the underwater bracing was found unnecessary.

REFERENCE: DiBiagio and Kjærnsli (1961)