SPECIALTY FOUNDATION SYSTEMS

Project: Billings Clinic Parking Garage
Billings, MT

Project Description:

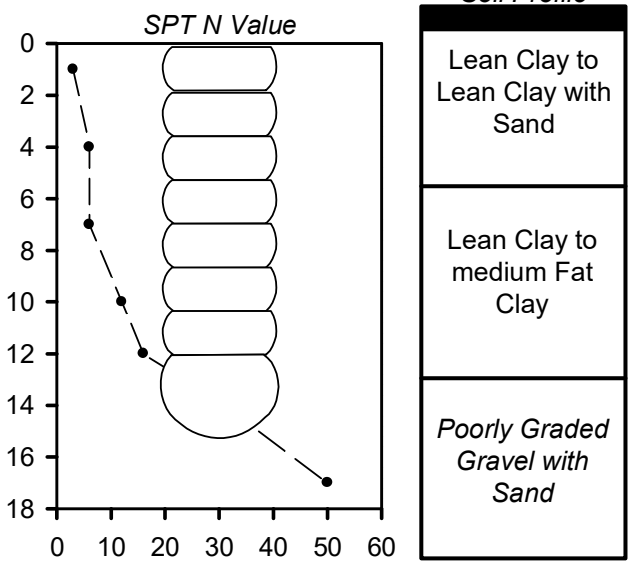
The project consisted of a new 3-story parking garage located at the northwest quadrant of 10th Ave North and North Broadway, Billings, Montana. As a cost savings measure Aggregate Piers were proposed in conjunction with the project Geotechnical Engineer as a value engineer alternate to deep foundations that were proposed to reach the bearing layer indicated on the soil profile. Not only did the piers save on project cost but also on overall schedule.

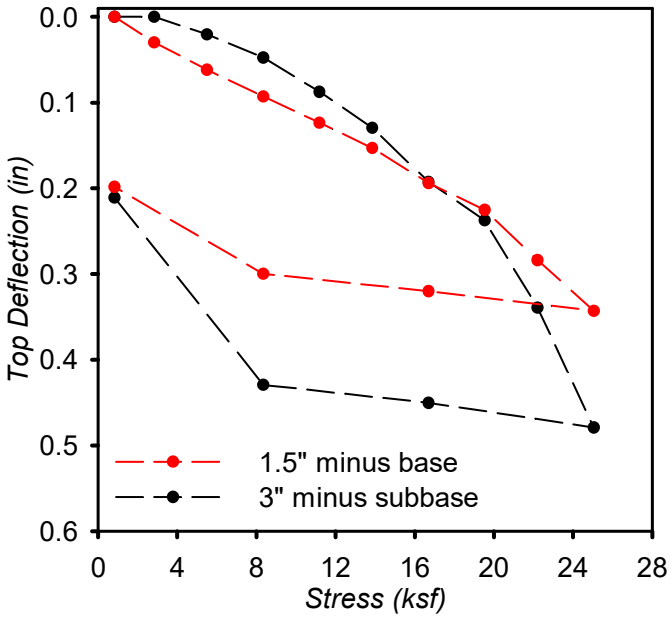
Project Details:

- 457 Aggregate Piers installed in 8 working days.
- The Aggregate Piers were designed to mitigate compressibility of a sandy clay fill and lean clay overlying a poorly graded gravel with sand layer and to increase the bearing capacity to 6000 psf.

Team Details:

- General Contractor – Sletten Construction Company
- Architect – A&E Design
- Structural – Whitten & Borges, PC
- Geotechnical – SK Geotechnical





Two load tests were performed using 2 different types of aggregate to build the piers with the following results:

- Design load per pier = 82 kips
- Total settlement at 150% of the design load:
  - Base material = 0.34”
  - Subbase material = 0.47”

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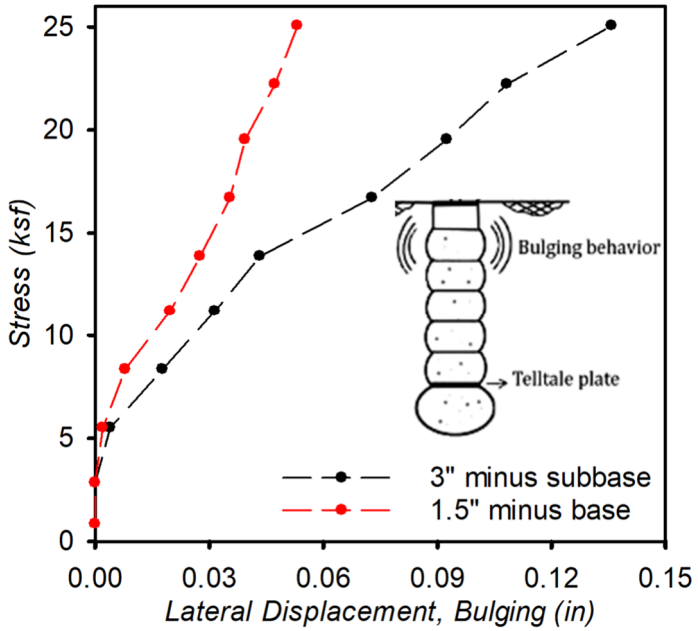
Numerical Analysis:

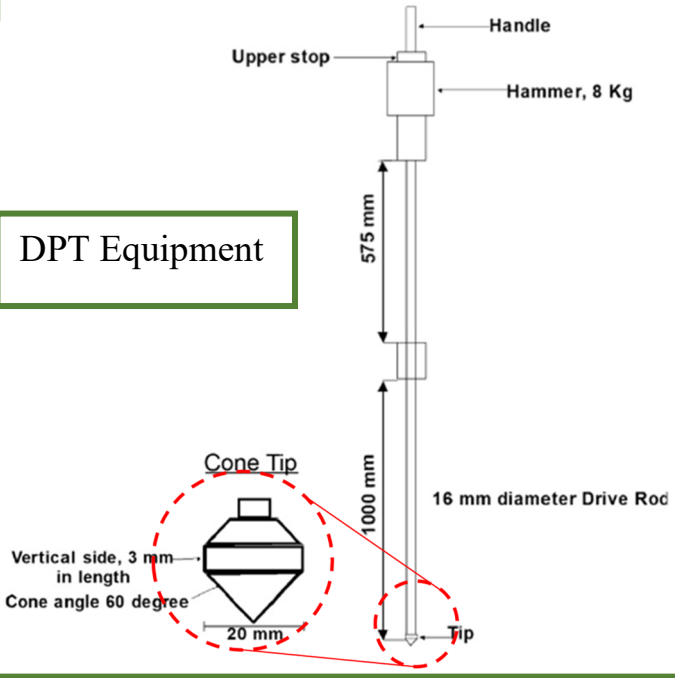
A numerical analysis using a finite difference software was used to understand the settlements measured during load testing. With this analysis, the variation in settlement between the tests could be explained.

Both materials performed better than expected, with measured settlements less than half of the design settlement of 1". Field testing showed that there was a difference of about 30% on the measured settlement that needed to be explained.

Construction of the first test pier was done with a 1.5" minus base coarse material and a 3" minus subbase coarse material was used for the second. The load schedule and the maximum applied load for both tests were the same.



DPT Equipment



Numerical Analysis Results:

During construction of the test aggregate piers, a Dynamic Penetration Test (DPT), was used to correlate the friction angle obtained for each pier. In the case of the pier built with base material, a friction angle of 52 degrees was achieved, while for the pier built with subbase material, a friction angle of 48 degrees was reached.

According to the numerical analysis, the maximum lateral displacement, or bulging, predicted for pier built with base material was about 0.05", while for the pier built with subbase material was about 0.14".

Based on these results, the type of material used to build the aggregate piers has an important role in the expected stiffness of the elements. The stiffer element will suffer less bulging and less vertical settlement in comparison to the less stiff pier.