
CHAPTER 4 – FIELD TEST RESULTS

OVERVIEW OF DATA

The appended Data Reports provide details about each test site, nail layout, soil conditions, and test results; and the reader is directed to the appendices for further details. A summary of the load test data is shown in Tables 4 through 7 for the four sites to provide a ready comparison of the information for the purposes of this summary report. The following notes explain the column headings for Tables 4 through 7.

Column Descriptions:

- *Nail Number/Installation Method*: Nail reference number from the field and installation method as discussed in Chapter 3.
- *Maximum Test Load*: Jack load at soil nail pullout if pullout occurred; otherwise maximum test load.
- *Maximum Movement*: Cumulative movement measured at the soil nail tail with dial gauges at the maximum test load just prior to unloading.
- *Residual Movement*: Cumulative movement measured at the soil nail tail with dial gauges after unloading to alignment load at maximum test load.
- *Pullout Failure Achieved?:* "Yes" indicates pullout failure achieved at the maximum test load. "No" indicates pullout failure was not achieved at the maximum test load.
- *Bond Length*: The distance from the tip of the bar farthest from the soil face to the edge of the coupler or smooth-walled PVC, whichever is shorter.
- *Average Drilling Rate (ft/min)*: Average of the drilling rate measurements within the bond length.
- *Calculated Average Bond Strength (psi)*: Bond strength as calculated per Equation (2), which follows Table 7.
- *Soil Type Along Bond Zone*: Soil type encountered in the bond zone based on nearby borings and drill cuttings observed during soil nail drilling. Soil density / consistency is based on nearby borings. The soil type is designated as Group Symbols in accordance with ASTM D2487 Unified Soil Classification System.

Table 4. Block 76 load test data summary.

Nail Number/ Installation Method	Maximum Test Load (kip)	Maximum Movement (in)	Residual Movement (in)	Pullout Failure Achieved?	Bonded Length (ft)	Average Drilling Rate (ft/min)	Calculated Average Bond Strength (psi)	Soil Type Along Bond Zone/ Density
A1	102.5	1.346	N/A	Yes	6.0	3.2	75.5	SP with gravel/ Dense
A2	68.5	1.174	N/A	Yes	6.0	1.5	50.5	
A3	111.6	1.496	N/A	Yes	6.0	1.1	82.2	
B1	136.6	0.720	0.164	No	6.0	3.4	151.0	GP with sand/ Dense
B3	141.4	0.744	0.172	No	6.0	3.1	156.3	
B4	56.5	1.162	N/A	Yes	6.0	5.6	62.4	SP/ Dense
C1	135.6	0.613	0.215	No	6.0	2.2	149.9	GP with sand/ Dense
C2	140.4	0.581	0.162	No	6.0	1.4	155.2	
C3	140.9	0.577	0.129	No	6.0	1.5	155.7	

Table 5. Posillico load test data summary.

Nail Number/ Installation Method	Maximum Test Load (kip)	Maximum Movement (in)	Residual Movement (in)	Pullout Failure Achieved?	Bonded Length (ft)	Average Drilling Rate (ft/min)	Calculated Average Bond Strength (psi)	Soil Type Along Bond Zone/ Density
A1	20.9	1.027	N/A ⁽¹⁾	Yes	6.0	0.6	13.2	SP/ Med. Dense
A2	20.9	1.804	N/A ⁽¹⁾	Yes	6.0	1.0	13.2	
B1	82.1	1.163	N/A ⁽¹⁾	Yes	6.0	1.7	71.2	
B2	91.8	2.953	N/A ⁽¹⁾	Yes	6.0	3.6	79.6	
B3	75.7	1.604	N/A ⁽¹⁾	Yes	6.0	-	65.6	
C1	151.9	1.577	0.963	Yes	6.0	0.4	131.7	
C2	116.5	2.007	N/A ⁽¹⁾	Yes	6.0	0.8	101.0	
C3 ⁽²⁾	73.5	0.836	N/A ⁽¹⁾	No ⁽²⁾	6.0	1.0	63.7	

Notes: (1) Final alignment load deflection of movement reading not collected.

(2) A wedge of soil failed behind the cribbing at a load of 73.5 kip.

Table 6. Sunset Mesa load test data summary.

Nail Number/ Installation Method	Maximum Test Load (kip)	Maximum Movement (in)	Residual Movement (in)	Pullout Failure Achieved?	Bonded Length (ft)	Average Drilling Rate (ft/min)	Calculated Average Bond Strength (psi)	Soil Type Along Bond Zone/ Density
A2	93.2	1.436	1.010	Yes	6.0	0.6	53.2	GP with sand/ Med. Dense – Dense ⁽¹⁾
A3	113.1	1.310	0.890	Yes	6.0	0.6	64.5	
B1	105.1	0.764	0.403	No	6.0	1.9	91.1	
B2	119.0	1.497	0.982	Yes	6.0	2.9	103.2	
B3	103.1	0.930	0.498	Yes	6.0	1.5	89.4	
C1	135.1	0.454	0.093	No	6.0	0.7	117.1	
C2	146.3	0.909	0.416	Yes	6.0	2.0	126.8	
C3	134.9	0.680	0.211	No	6.0	0.1	116.9	

Notes: (1) Test boring data not available, based on observation and drilling action.

Table 7. Olympia load test data summary.

Nail Number/ Installation Method	Maximum Test Load (kip)	Maximum Movement (in)	Residual Movement ⁽¹⁾ (in)	Pullout Failure Achieved?	Bonded Length (ft)	Average Drilling Rate (ft/min)	Calculated Average Bond Strength (psi)	Soil Type Along Bond Zone/ Consistency
A1	35.4	0.400	N/A	Yes	10.0	5.0	15.0	SC/ Med. to Stiff
A2	40.4	0.676	N/A	Yes	10.0	3.5	17.1	
A3	30.1	N/A	N/A	Yes	10.0	3.0	12.8	
B1	22.9	0.676	N/A	Yes	7.0	4.5	19.2	
B2	24.1	2.273	N/A	Yes	7.0	3.5	20.2	
B3	22.3	1.317	N/A	Yes	7.0	5.0	18.7	
C1 ⁽²⁾	31.6	1.155	N/A	Yes	10.0	5.7	18.5	
C2 ⁽²⁾	25.4	0.175	N/A	Yes	10.0	5.3	14.9	
C3 ⁽²⁾	41.6	2.201	N/A	Yes	10.0	4.4	24.4	
D1	40.4	N/A	N/A	Yes	10.0	2.5	23.7	
D2	30.4	0.404	N/A	Yes	10.0	3.8	17.8	
D3	32.9	1.142	N/A	Yes	10.0	3.1	19.3	

Notes: (1) Residual movement not applicable at final pullout cycle. Residual movement observed at intermittent cycles in data and plots in Appendix 4.

(2) Not installed in conformance to Method C; grout was partially flushed from unbonded length.

Load Test Interpretation Methods

For test nails that underwent geotechnical failure during testing, the average bond strength along the bond zone was calculated using the following expression:

$$\alpha = \frac{Q_{ultimate}}{\pi D_{nom} L_{BV} \cdot 12} \quad (2)$$

where:

- L_{BV} = Test nail bonded length [ft]
- $Q_{ultimate}$ = Pullout load [lb]. If pullout does not occur at the maximum test load, it is noted as an asterisk (*) in the table
- α = Average ultimate bond strength [psi]
- D_{nom} = Nominal diameter of the drill hole (drill bit diameter) [in]

The bonded length was considered from the tip of the bar at the bottom of the bond zone to the bottom of the unbonded zone. The length of the coupler was considered part of the bond zone since the measured top of grout location was generally centered at the interface between the PVC and coupler. It was expected that the load would transfer to the top of the grout in the bond zone from the threaded bar.

Generally, the grout body diameter will be larger than the nominal drill hole diameter. Consequently, the actual average ultimate bond strength may be less than the value given by Equation (2). However, it is important to recognize that the actual diameter of the bond zone is rarely known, and design of soil nails must necessarily be done based on the nominal drill hole diameter.