12-2 PERMISSIBLE HORIZONTAL LOAD FOR STANDARD PLAN AND STEEL HP PILES

The permissible horizontal load for deep foundations at abutments is the load that results in a horizontal displacement of 0.25 inch at the top or cut-off elevation of the pile/shaft. The applied horizontal load on the pile/shaft under the LRFD Service-I Limit State load combination must be less than the permissible horizontal load.

The permissible horizontal load for (Caltrans) Standard Plan piles as well as steel HP piles when acting individually and fully embedded in soils with horizontal ground surface and with a corrected standard penetration resistance value, ($N1_{60}$), of 10 or greater may be taken as those given in Tables 12-2-1 and 12-2-2 for granular and cohesive soils, respectively. The tables show recommended permissible horizontal loads for two cases of pile embedment depth, zero (0.0) and five (5.0) feet below the Finished Ground (FG) surface as shown in Figure 1. The permissible horizontal loads are tabulated for different values of angle of internal friction in granular drained soil (ϕ_f), and undrained shear strength (S_u) in cohesive soil.

Table 12-2-3 shows minimum required pile lengths when Tables 12-2-1 and 12-2-2 are used. When Standard Plan piles are used in a group, the permissible horizontal load of an individual pile must be reduced by the applicable group reduction factor. The factored structural resistance of the piles shall be also compared to the factored horizontal loads in the LRFD Strength load combinations.

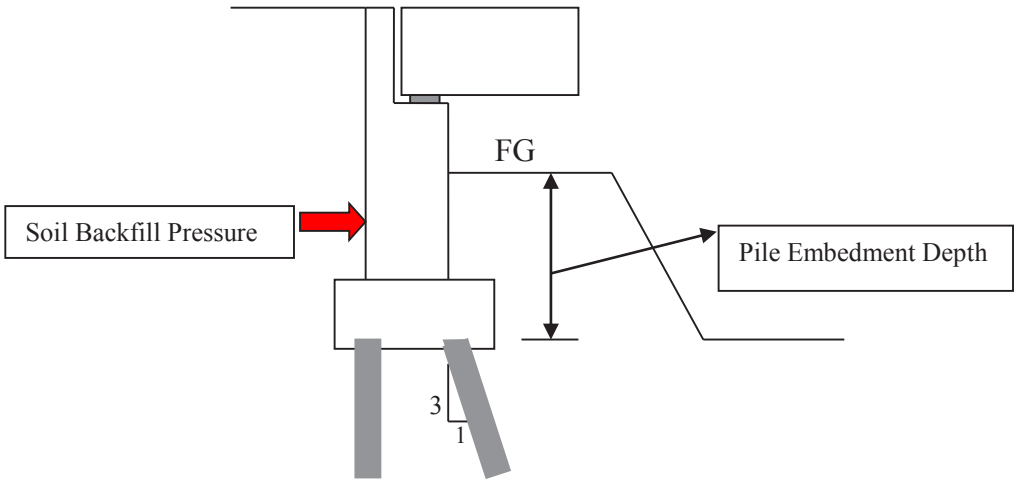

Figure 1. Elevation of the abutment showing pile embedment depth

For battered piles (with negative batter) as shown in Figure 1, where the axial force of the pile acts in the opposite direction of active earth pressure, a reduction factor must be applied to Tables 12-2-1 and 12-2-2 readings. Unless site-specific information indicates otherwise, the reduction factors must be taken as 0.60 for granular soil (sand), and 0.75 for cohesive soil (clay). The horizontal component of a battered pile's axial load may be subtracted from the total lateral load when calculating the applied horizontal load on the pile group.

Table 12-2-1 Permissible Horizontal Load on Vertical Standard Plan and Steel HP Piles in Granular Soil for the LRFD Service-I Load Combination

Pile Type		Permissible Horizontal Load (kips) Cut-off Embedment = 0.0 feet			Permissible Horizontal Load (kips) Cut-off Embedment = 5.0 feet		
		ϕ_f = 30°	ϕ_f = 32°	ϕ_f = 34°	ϕ_f = 30°	ϕ_f = 32°	ϕ_f = 34°
CIDH Concrete (24")	$P_{Service}$=0 kips	13	15	17	25	30	34
	$P_{Service}$=200 kips Compression	17	22	25	34	40	46
CIDH Concrete (16")	$P_{Service}$=0 kips	6	7	8	13	15	17
	$P_{Service}$=140 kips Compression	9	11	12	19	22	25
Steel Pipe 14" (Class 90, Alt W)		8	10	11	18	22	26
Steel Pipe 14" (Class 90, Alt V)		9	11	13	20	24	29
Steel Pipe 14" (Class 140, Alt W)		9	10	12	19	23	27
Steel Pipe 14" (Class 140, Alt V)		10	11	13	21	25	30
Steel Pipe 16"(Class 200, Alt W)		11	13	15	23	27	32
Driven Concrete 12" (Class 90/140, Alt X)		6	7	8	15	18	20
Driven Concrete 14" (Class 200, Alt X)		10	11	13	20	23	27
Driven Concrete 15" (Class 90/140/200, Alt Y)		10	11	13	19	22	25
HP 10x42 (90 kip – Service Capacity)		6	7	8	16	20	24
HP 10x57 (140 kip – Service Capacity)		7	8	9	18	22	26
HP 14x89 (200 kip – Service Capacity)		12	14	16	24	29	34

Table 12-2-2 Permissible Horizontal Load on Vertical Standard Plan and Steel HP Piles in Cohesive Soil for the LRFD Service-I Load Combination

Pile Type		Permissible Horizontal Load (kips) Cut-off Embedment = 0.0 feet			Permissible Horizontal Load (kips) Cut-off Embedment = 5.0 feet		
		S_u=1.0 ksf	S_u=2.0 ksf	S_u= 3.0 ksf	S_u=1.0 ksf	S_u=2.0 ksf	S_u= 3.0 ksf
CIDH Concrete (24")	$P_{Service}$=0 kips	19	29	38	23	37	48
	$P_{Service}$=200 kips Compression	25	39	50	31	49	62
CIDH Concrete (16")	$P_{Service}$=0 kips	9	15	20	13	21	28
	$P_{Service}$=140 kips Compression	13	21	27	18	28	36
Steel Pipe 14" (Class 90, Alt W)		12	21	27	17	29	38
Steel Pipe 14" (Class 90, Alt V)		13	22	29	19	31	41
Steel Pipe 14" (Class 140, Alt W)		13	22	29	18	30	40
Steel Pipe 14" (Class 140, Alt V)		14	23	31	19	32	42
Steel Pipe 16" (Class 200, Alt W)		16	26	35	21	36	47
Driven Concrete 12" (Class 90/140, Alt X)		10	15	19	14	21	27
Driven Concrete 14" (Class 200, Alt X)		14	21	27	18	28	36
Driven Concrete 15" (Class 90/140/200, Alt Y)		13	21	27	18	28	36
HP 10x42 (90 kip – Service Capacity)		9	16	21	14	23	31
HP 10x57 (140 kip – Service Capacity)		10	17	23	15	25	34
HP 14x89 (200 kip – Service Capacity)		16	27	36	22	37	49

Notes:

- The permissible horizontal loads of CIDH concrete piles have been calculated for zero as well as maximum axial compressive load (Service) that can be applied to the pile,

as shown in the table. After calculating axial loads on the pile for the LRFD Service-I load combination, the designer may use interpolation (between the given values for axial load) to determine permissible horizontal load.

- The permissible horizontal load on piles outside the range of embedment length or other parameters shown in Tables 12-2-1 and 12-2-2, are the lesser of that determined by geotechnical analysis, and the structural resistance.

Table 12-2-3 Minimum Required Length of Vertical Piles (ft)

Pile Type	Pile in Granular Soil	Pile in Cohesive Soil
CIDH Concrete (24")	45	32
CIDH Concrete (16”)	35	25
Steel Pipe 14" (Class 90, Alt W)	35	25
Steel Pipe 14" (Class 90, Alt V)	35	25
Steel Pipe 14" (Class 140, Alt W)	35	25
Steel Pipe 14" (Class 140, Alt V)	35	25
Steel Pipe 16" (Class 200, Alt W)	35	28
Driven Concrete 12" (Class 90/140, Alt X)	33	25
Driven Concrete 14" (Class 200, Alt X)	35	25
Driven Concrete 15" (Class 90/140/200, Alt Y)	35	25
HP 10x42 (90 kip – Service Capacity)	30	25
HP 10x57 (140 kip – Service Capacity)	33	25
HP 14x89 (200 kip – Service Capacity)	40	30

Notes:

- The minimum required pile length has been selected as the maximum of: depth to point of zero moment, depth to point of zero shear, and critical length of the pile/shaft (when applicable).
- Case specific analysis is required for existing piles if length is less than the specified minimum length.

References:

- Memo to Designers 3-1 "Deep Foundations" (2014).
- California Amendments to 6th edition of "AASHTO LRFD Bridge Design Specifications", (2014).
- S. Logeswaran, A. Perez-Cobo, H. Valencia, and M. Islam, "Case Study on Lateral Capacity of Caltrans' Standard Plan Piles (for LRFD Service-I Limit State)" additions by Substructures Committee, California Department of Transportation, 2013 (unpublished).
- M. Yashinsky, T. Masroor, D. Tavatli, and M. Islam, "Lateral Capacity of Standard Piles (Seismic)", California Department of Transportation, 2005 (Internal Report).