



## 3-7 PILE LAYOUTS FOR STANDARD PLAN RETAINING WALLS

### Introduction

This Design Aid provides the following attachments for pile foundations for Type 1 retaining walls.

- Attachment A-Load Case 1 Pile Layouts
- Attachment B-Load Case 2 Pile Layouts
- Attachment C-Load Case 3 Pile Layouts

The typical design provided in the attachments is used in conjunction with:

- 2010 Revised Standard Plans B3-1A, B3-1B, B3-1C
- XS 14-200 “Type 1 Retaining Wall Pile Layout Details”
- Memo to Designers 5-5.
- Bridge Design Aids 12-2

The design is based on *AASHTO Load and Resistance Factor Design (LRFD) Bridge Design Specifications (BDS)*, 4th Edition, 2007 and the 2011 California (CA) Amendments. Design based on the 6th Edition, 2014 CA Amendments, will be the same due to the 2011 CA Amendments.

Load cases 1, 2, and 3 as depicted here and on the standard designs should not be confused with the load combinations defined in AASHTO LRFD BDS.

### General

#### Dimensioning

Design Height ( $H$ ): design height of a given section of a retaining wall from the top of the wall stem to the top of the footing.

Width of footing ( $W$ ): width of the footing from the toe to the back of the footing. The widths of the footings founded on piles are generally narrower than the width of spread footings for the same design height.



## Pile Layouts

The pile layout patterns vary with load case and design height. Each standard load case and corresponding design height is assigned a specific pile layout pattern. Special design and changes to the pile layout patterns will be required for modified loading conditions due to additional surcharges, changed wall geometry, increased seismic loads, different soil properties, varied backfill conditions, added sign structures, etc.

### Assumed lateral capacity per pile:

- Service: 18 kips plus batter component
- Strength: 30 kips plus batter component
- Extreme: 40 kips plus batter component
- Pile batter shown 1:3

### Assumed axial capacity per pile:

- 90 kips (Service load)

### Pile spacing:

- Pile spacing,  $P$ : spacing of the front row(s) of battered piles.
- Pile spacing,  $Q$ : spacing of the back row(s) of vertical piles.

The dimensions for  $P$  and  $Q$  are maximums. The spacing of the piles may be reduced to accommodate the given footing geometry. Pile spacing less than 3'-0" center to center is not allowed.

### Pile loads and resistances:

Pile loads and resistances are given on a per foot basis along the length of the footing. For Load Case 1, pile loads and resistance values are given for Service, Strength, Extreme Event I (seismic loads), and Extreme Event II (vehicular impact). For Load Cases 2 and 3, pile loads and resistance values are given for Service, Strength, and Extreme Event I (seismic loads).

- $\Sigma V$  = value of the maximum applied vertical load (kips/ft).
- $\Sigma H$  = value of the maximum applied horizontal load (kips/ft).
- $H'_{90}$  = value of the maximum horizontal resistance of the piles (kips/ft).

The maximum pile resistance values  $H'_{90}$  have been evaluated according to the pile group



reduction factors listed in table 10.7.2.4-1 of the 2011 California Amendments for 14” piles. Other pile sizes and pile types require special design. A special design is also required if the geotechnical capacities and/or the structural capacities of the piles are less than the capacities assumed in this design. Pile deflection limits are to be evaluated on a project by project basis.

Refer to XS 14-200 for other design details.

**Stem:**

All dimensions and steel reinforcement are as shown in the Revised Standard Plans dated April 20, 2012.

**Footing:**

The footing dimensions and steel reinforcement must be modified as shown on XS14-200 for pile foundations.

**Design**

The pile layouts attached here and depicted on XS 14-200, were developed using the design notes on Revised Standard Plans B3-1A through BC-1C. Also note the following:

- Design height, *H*, may be exceeded by 6” before going to the next design height.
- Concrete barrier type 732, 736, or 742 may be attached to the top of the stem.
- The concrete barrier self weight is included in the total vertical weight and inertia of the system.
- Soundwalls are not considered in this design. Refer to Standard Details Sheets, Section 14-Retaining Walls with Soundwalls for the design of retaining walls with soundwalls.
- Concrete Architectural Treatment up to 6” thick (75 psf) is included on stem.

All other applied loads require special design.

LRFD Factors for Load Cases					
COMPONENT	Service	Strength 1a	Strength 1b	Extreme I (EQ)	Extreme II (CT)
Soil	1.0	1.35	1.0	1.0	1.0
Concrete DL	1.0	1.25	0.9	1.0	1.0
Live Load Surcharge	1.0	1.75	1.75	N/A	N/A
Active Earth Pressure	1.0	1.5	1.5	1.0	1.0