FULLER PILE HEAD CONNECTION DETAILING

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Introduction

Deep foundation elements are typically designed as either free head or fixed head elements. Like other deep foundation elements, Fuller Piles and their connections to pile caps are designed and detailed by a specialty licensed engineer or "delegated designer" as part of a delegated design process. To appropriately design and detail Fuller Piles, the delegated designer needs to understand what loads are being applied to the head of the piles so that they can work with the project geotechnical engineer (or specialty geotechnical engineer) to determine shear, moment, and deflection along the length of pile including all actions that happen near the top of the pile. Pile design loads are typically provided by the engineer of record for the structure and are commonly shown on structural engineering drawings or in project specifications. When these loads are provided, they should be labeled as ASD or LRFD loads so that the delegated designer is clear whether or not load factors have already been accounted for in the provided loads.

Free Head Piles

Like other deep foundation elements, Fuller Piles are detailed as free head elements by using minimum embedment into the pile cap. 2021 IBC Section 1810.3.11 requires all cast in place elements to be embedded a minimum of 3 in. into the pile cap and further requires a clear edge distance from the pile surface to the edge of the pile cap of at least 4 in. As such, typical free head Fuller Piles have a top of pile elevation at or just below the pile cap bottom reinforcing layer. Note that when tension is a design consideration and free head piles are detailed, a mechanical device must tie the pile directly to the pile cap. Additional details considered by the delegated designer specific to seismic design are presented in 2021 IBC Sections 1810.3.11.1 and 1810.3.11.2.

Fixed Head Piles

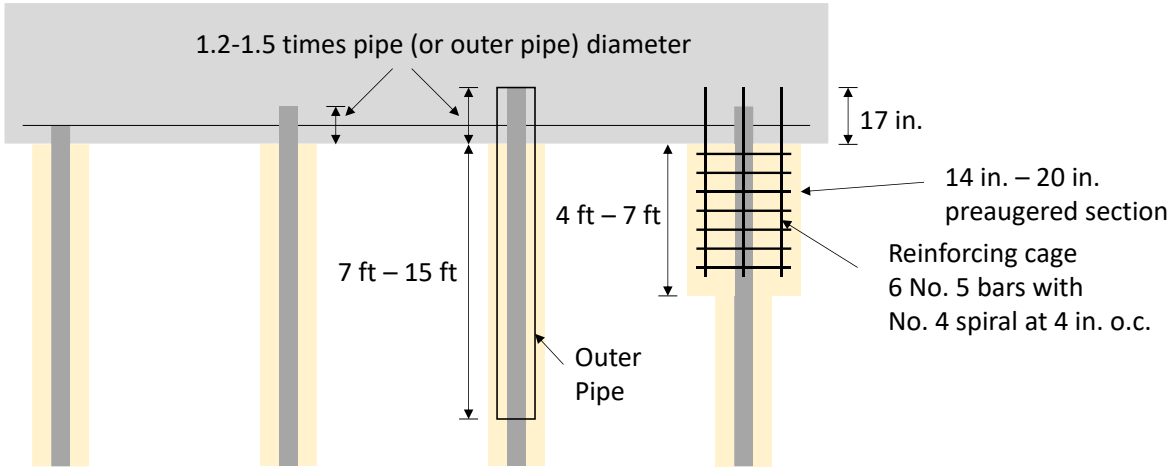
For low and moderate lateral load conditions, the relatively small pipe diameter of the Fuller Pile makes it ideal for fixed head detailing using a longer pile embedment into the pile cap. When Fuller Piles are embedded above the bottom layer of the pile cap reinforcing and at least 1.2 times the pipe diameter into the pile cap, the pile may be considered fully fixed and capable of developing the moment capacity of the pile. When approved by the engineer of record (i.e., pile cap strength resisting punching shear, also called two-way shear around the pile, is acceptable), an embedment of 1.5 times the pipe diameter is recommended.

For large lateral load conditions, there are many options for increasing the moment capacity of the pile head. In some cases, an outer pipe in the upper portion of the pile may be detailed by the delegated designer. Recent research has found that it is advantageous to use preaugering in the upper 4-7 ft of the Fuller Pile so that an outer rebar cage can be installed in this area and developed 17 in. into the pile cap above. When this detail is combined with pile embedment, the Fuller Pile can be very economically designed and detailed as significantly stronger than all competing deep foundation elements used in practice. Additional details considered by the delegated designer specific to seismic design are presented in 2021 IBC Sections 1810.3.11.1 and 1810.3.11.2.

Tension Considerations

The standard Fuller Pile with four bolts per section splice has an LRFD tensile strength controlled by bolt shear equal to ϕT_n = 64 k (based on two A325-N bolts in double shear). For design cases where the factored tensile demand is greater than 64 k, larger or stronger bolts can be specified by the delegated designer. Bolt bearing on the pipe wall is a design consideration, but it does not usually control since the wall thickness is sized for installation torque. At the pile head, the tension load path is typically detailed by the delegated designer using a cap (not usually required for compression), steel studs welded around the embedded portion of the pile, or other appropriate detail.

The following figure and table do not consider all the custom pile head details used for Fuller Piles. However, they have been found useful to the engineer of record responsible for the supported structure.



Free Head Fixed Head Options

Fixed Head Flexural Design Strength ϕM_n for Provided P_u

Fixed Head Detail	0 k	100 k	200 k
FP550 – 20 in. Auger	1,500 k-in.	1,700 k-in.	1,850 k-in.
FP550 – 18 in. Auger	1,300 k-in.	1,400 k-in.	1,450 k-in.
FP550 – 16 in. Auger	1,000 k-in.	1,075 k-in.	1,080 k-in.
FP550 – 14 in. Auger	800 k-in.	825 k-in.	800 k-in.
FP450 – 20 in. Auger	1,300 k-in.	1,500 k-in.	1,650 k-in.
FP450 – 18 in. Auger	1,000 k-in.	1,200 k-in.	1,300 k-in.
FP450 – 16 in. Auger	825 k-in.	835 k-in.	830 k-in.
FP450 – 14 in. Auger	600 k-in.	640 k-in.	630 k-in.
FP350 – 20 in. Auger	1,200 k-in.	1,400 k-in.	NA
FP350 – 18 in. Auger	960 k-in.	1,080 k-in.	NA