

times the cross-sectional area of the concrete fill developed into the cap and extending into the fill a length equal to two times the required cap embedment, but not less than the development length in tension of the reinforcement.

1810.3.11.2 Seismic Design Categories D through F. For structures assigned to *Seismic Design Category* D, E or F in accordance with Section 1613, deep foundation element resistance to uplift forces or rotational restraint shall be provided by anchorage into the pile cap, designed considering the combined effect of axial forces due to uplift and bending moments due to fixity to the pile cap. Anchorage shall develop a minimum of 25 percent of the strength of the element in tension. Anchorage into the pile cap shall be capable of developing the following:

1. In the case of uplift, the least of the following: nominal tensile strength of the longitudinal reinforcement in a concrete element; the nominal tensile strength of a steel element; the frictional force developed between the element and the soil multiplied by 1.3; and the axial tension force resulting from the load combinations with overstrength factor in Section 12.4.3.2 of ASCE 7.

2. In the case of rotational restraint, the lesser of the following: the axial force, shear forces and bending moments resulting from the load combinations with overstrength factor in Section 12.4.3.2 of ASCE 7 or development of the full axial, bending and shear nominal strength of the element.

Where the vertical lateral-force-resisting elements are columns, the pile cap flexural strengths shall exceed the column flexural strength. The connection between batter piles and pile caps shall be designed to resist the nominal strength of the pile acting as a short column. Batter piles and their connection shall be capable of resisting forces and moments from the load combinations with overstrength factor in Section 12.4.3.2 of ASCE 7.

1810.3.12 Grade beams. For structures assigned to *Seismic Design Category* D, E or F in accordance with Section 1613, grade beams shall comply with the provisions in Section 21.12.3 of ACI 318 for grade beams, except where they have the capacity to resist the forces from the load combinations with overstrength factor in Section 12.4.3.2 of ASCE 7.

1810.3.13 Seismic ties. For structures assigned to *Seismic Design Category* C, D, E or F in accordance with Section 1613, individual deep foundations shall be interconnected by ties. Unless it can be demonstrated that equivalent restraint is provided by reinforced concrete beams within slabs on grade or reinforced concrete slabs on grade or confinement by competent rock, hard cohesive soils or very dense granular soils, ties shall be capable of carrying, in tension or compression, a force equal to the lesser of the product of the larger pile cap or column design gravity load times the seismic coefficient, S_{DS} , divided by 10, and 25 percent of the smaller pile or column design gravity load.

Exception: In Group R-3 and U occupancies of light-frame construction, deep foundation elements supporting foundation walls, isolated interior posts detailed so the element is not subject to lateral loads or exterior decks and patios are not subject to interconnection where the soils are of adequate stiffness, subject to the approval of the *building official*.