Federation of Piling Specialists

The Design of Piles to BS EN 1997:1 and BS EN 1992:1

Many piling and piled retaining wall designs are now being carried out in accordance with Eurocodes BS EN 1997:1 Geotechnical Design and BS EN 1992:1 Design of Concrete Structures. Experience gained during the design process has highlighted a number of areas where the members of the FPS believe that clarification is needed. The following highlight the FPS position and technical advice for all piles excluding micropiles:

1.0 Minimum Number of Reinforcing Bars - Bored Piles

BS EN 1536 (1999) Cl. 7.6.2.3 states that the minimum requirement for longitudinal reinforcement is 4 bars 12mm diameter. There is no reference to design bending moment or shear force.

BS EN 1992:1 Cl. 9.8.5 requires bored piles (which includes CFA) to have a minimum of 6 longitudinal bars, where reinforcement is required to resist bending or shear. The minimum bar size is 16mm.

The FPS position is as follows:

- If there is NO design shear or bending moment, BS EN 1536:2010, cl. 7.5.2.2 and 7.5.2.3 apply.
- If there iS a design shear or bending moment, BS EN 1992, cl. 9.8.5 applies UNLESS 'other provisions' are made, such as specifically designing for the minimum resistance offered in any direction by the proposed four/five bar cage.

2.0 Design Lap Lengths

In many instances the interpretation of the required lap length for pile and diaphragm wall cages has increased from the requirements as specified in BS 8110. The main variation is based on the assessment of the bond condition.

The type of bond being ‘good’ or ‘poor’ needs to be assessed on a case by case basis. A ‘poor’ bond condition does not apply to the typical case of vertical bars cast under bentonite. This subject is covered by the Arup paper by Jones and Holt (published in The Structural Engineer) which links the bond assessment with the effects of support fluid. The FPS position is that provided the cover to the main bar is twice the diameter of the main bar then conditions of good bond should apply.

3.0 *Unreinforced Pile Section in Compression Below Design Reinforcement Cage*

It is normal practice with pile design to reinforce the upper section of the pile to below the level of any induced bending moment or shear, and curtail the cage where the pile is in pure compression. If the requirements of Section 12 of EC2 were imposed on this element of the pile the effect would be quite a significant reduction in the designed compression capacity of the pile section. The interpretation of FPS members is that the provisions of Section 12 are intended to eliminate the possibility of significant tensile stresses developing in the concrete given its reduced ductility with time. As a pile would effectively be reinforced to a point where it is in pure compression and completely restrained by the ground, the additional rules are not appropriate.

The FPS position is that any unreinforced section of pile below a cage designed to the level of any induced bending or shear may be designed to carry the full compressive capacity of the concrete.

4.0 Analysis method for BS EN 1997:1 Geotechnical Design

Geotechnical designs under BS EN 1997:1 within UK design practice should generally be carried out in accordance with the Calculation Method.

5.0 Ground Anchor Design

Ground anchors should continue to be designed in accordance with BS 8081 until an addendum to BS EN 1997 has been issued.

6.0 Uneven Number of Longitudinal Bars in Piles

Although not explicitly included within BS EN 1997:1 or BS EN 1992:1, Clause **7.5.2.10** Within BS EN 1536:2010 states that for circular piles, non symmetrical cages should be avoided. The FPS position is that as long as non symmetrical cages are adequately positioned and held in place during concreting there is no reason not to design and install such cages.

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