3.7. SEISMIC DESIGN REQUIREMENTS FOR FOUNDATIONS

3.7.1. General

3.7.1.1 – The following paragraphs apply for the design of concrete foundation elements, such as footings, tie-beams, foundation beams, foundation slabs, foundation walls, pile caps and piles, as well as for connections between such elements, or between them and vertical concrete elements. The design of these elements shall follow the rules of EN 1998-5:2004, 5.4.

3.7.1.2 – Design values of the action effects E_{Fd} on the foundations shall be derived as follows:

$$E_{Fd} = E_{F,G} + \Omega E_{F,E} \qquad \textbf{(3.28)}$$

3.7.1.3 – In box-type basements of dissipative structures, comprising: a) a concrete slab acting as a rigid diaphragm at basement roof level; b) a foundation slab or a grillage of tie-beams or foundation beams at foundation level, and c) peripheral and/or interior foundation walls, columns and beams (including those at the basement roof) are expected to remain elastic under the seismic design situation. Shear walls should be designed for plastic hinge development at the level of the basement roof slab. To this end, in walls which continue with the same cross-section above the basement roof, the critical region should be taken to extend below the basement roof level up to a depth of h_{cr} (see **3.4.3.1**). Moreover, the full free height of such walls within the basement should be dimensioned in shear assuming that the wall develops its flexural overstrength 1.1 M_{Rd} at the basement roof level and zero moment at the foundation level.

3.7.2. Tie-beams and foundation beams

3.7.2.1 – Stub columns between the top of a footing or pile cap and the soffit of tie-beams or foundation slabs shall be avoided. To this end, the soffit of tie-beams or foundation slabs shall be below the top of the footing or the pile cap.

3.7.2.2 – Axial forces in tie-beams or tie-zones of foundation slabs in accordance with 5.4.1.2(6) and (7) of EN 1998-5, should be taken in the verification to act together with the action effects derived for the seismic design situation.

3.7.2.3 – Tie-beams and foundation beams should have a cross-sectional width of at least $b_{w,min} = 250$ mm and a cross-sectional depth of at least $h_{w,min} = 400$ mm.

3.7.2.4 – Foundation slabs arranged in accordance with EN 1998-5:2004, 5.4.1.2(2) for the horizontal connection of individual footings or pile caps, should have a thickness of at least $t_{min} = 200$ mm and a reinforcement ratio of at least $\rho_{s,min} = 0.2\%$ at the top and bottom.

3.7.2.5 – Tie-beams and foundation beams should have along their full length a longitudinal reinforcement ratio of at least $\rho_{b,min} = 0.4\%$ at both the top and the bottom.

3.7.3. Connections of vertical elements with foundation beams or walls

3.7.3.1 – The common (joint) region of a foundation beam or foundation wall and a vertical element shall follow the rules of **3.3.4.1** as a beam-column joint region.