Module 29/Topic 17

PRESTRESSING IN FOUNDATIONS

Like shells, prestressing as a technique has also made its foray in the field of foundations.

Prestressed concrete has been a revolutionary development of the 20th century in the field of civil engineering, both as a ‘material’, if it may be called so, and as a concept. The principle of both “full prestressing” (no tensile stresses allowed), and “partial prestressing” (tensile stresses allowed to develop under certain conditions of loading) find applications in foundation engineering.

The greatest advantage of prestressing is that it gives uncracked sections, which, because of water-tightness, offers higher resistance to chemical attack that leads to disruption of concrete and corrosion of the reinforcement. The latter aspects are particularly important in the case of foundations in the marine environment.

The field of prestressed concrete in foundations includes water reservoirs, swimming pools, pavements, rafts, forge hammer foundations, anchorages of cable suspension bridges, dams, paving slabs for canals, as also underpinning jobs. Vast potential also exists in works relating to marine and undersea structures, pipes, poles, pavements, sleepers and the like.

17.1 Prestressed concrete piles

Prestressed concrete piles constitute quantitatively the single largest and the most important field of application of prestressing in foundation engineering. These piles are widely used today for marine and building foundations throughout the world. According to available reports, the growth in their use and constant extension of their fields of application have been phenomenal. Prestressing finds application not only in bearing piles, but also in sheet piles, combined bearing and sheet piles, pier trestle and jetty bent piles, high tower and stack foundation piles, pile caissons, anchor piles, fender piles, soldier piles, dolphins, etc. As per a report available from 1970, there was an annual world consumption of over 60 million metre length of prestressed concrete piles, covering a host of countries both in the West and the East.

While prestressing is directly effective when the in-service stresses are tensile (bending or direct) its influence in situations where the in-service loads are compressive lies in its ability to resist tensile stresses developing during such phases as handling, hoisting and pitching, and also during the recoiling phase of driving.

The advantages of prestressed concrete piles can be summarised as: 1) high strength, 2) economy of design, production and installation, 3) uniformly high quality and strength, leading to great scope for mass production, 4) crack-free handling,
hauling, pitching and driving, 5) ability to penetrate hard strata, 6) production in large lengths and diameters and ease in splicing to form total lengths of the order of 75 m, 7) durability under adverse environment, 8) ability to resist dynamic effects, and 9) ability to carry heavy loads to weak soils, as deep foundations.

Prestressed concrete piles are precast and may be pre-tensioned or post-tensioned, depending upon the size of cross section. Smaller sections are invariably pre-tensioned, while larger ones are post-tensioned.

17.1.1 Splicing of prestressed concrete piles

Splicing is the act of joining individual short lengths to avoid the need for casting long single piles. Effective splicing of prestressed concrete piles can reduce and eliminate many problems associated with the installation of long piles. Proper splicing methods also eliminate the need to predict precise pile lengths and allow extensions of piles whenever necessary.

There are over 20 proprietary designs of pile splices. Of these, the cement-dowel splice (Fig.17.1) is simple, and has been found to be highly satisfactory in performance, as ascertained from tests. In this method of splicing, the protruding cast-in dowels at the bottom of the top section are inserted into the corresponding holes at the top of the bottom section. The joint is then covered by a temporary sleeve for pouring a cement called "Florok plasticised cement" at a temperature of 16°C. This cement takes only 15 minutes to set. The strength of this splice in compression, tension and flexure has been found to be as high as 100 percent, thereby ensuring perfect continuity.

Kurian (2013: Secs.2.2.2, 2.2.3, 2.2.4) also briefly covers prestressing in pavements, underpinning, retaining walls and raft foundations for high-rise structures. Interested readers are urged to go through the same to obtain a broader understanding and appreciation of the scope of prestressing in foundations.

Prestressed ground anchors, which constitutes a major field of prestressing in foundations, is covered under Topic 22.