Pre-tensioning in civil engineering

Profession

Introduction : The idea of pre tensioning has been around for centuries and has been applied to many forms, such as: wagon wheels, wooden barrels etc. In these cases heated metal is made to just fit an object. When the metal cools it contracts and induces prestress into the object thereby strengthening it. The idea of pretensioned concrete has been around since the late 19th century, but its use was limited by the quality of materials available at the time.

It wasn’t until the 1920s that materials of a suitable quality were available in sufficient quantity to allow pretensioned concrete to be used with confidence. The pioneers of this field were Freyssinet, Magnel and Hoyer. Description: In pre-tensioned concrete tensile elements such as cables, ribbons, or rods are clamped under calculated tensilestress(Stage 1). Concrete is cast around these elements and allowed to cure(Stage 2). When fully hardened the clamps are released and the stress is transferred within the rigid concrete (stage 3).

As long as a load is applied within the design limit, the concrete structural element will never be subjected to tensile stress of sufficient force to causefailure. Pre-tensioning can be used in pre-cast as well as in cast-in-place construction. Most of the pre-tensioning construction techniques are patented although the basic principle used in all of them is common and is well known. Hard drawn steel wires which are indented or crimped are preferred for pre-tensioned elements because of their superior bond characteristics. Small diameter wires of 2 to 5 mm are mostly used in the form of strands comprising two, three or seven wires.

High Strength Concrete mix: Pre-stressed concrete requires concrete which has a high compressive strength, with comparatively higher tensile strength. Low shrinkage, minimum creep characteristics and a high value of Young’s modulus are generally deemed necessary for concrete used for prestressed members. Uses: Common uses include Railway Sleepers, Communications Poles, Pretensioned Precast “ Hollowcore” slabs, Pretensioned Precast Double T units –for very long ps, Pretensioned precast inverted T beams – for short-p bridges, Pretensioned precast PSC piles, Pretensioned precast portal frames.

Alternatives: The alternative to pre-tensioning is post-tensioning. In a post-tensioned beam, the tendons are stressed and each end is anchored to the concrete section after the concrete has been cast and has attained sufficient strength to safely withstand the prestressing force. In the posttensioning method, tendons are encased in a duct or sheath or coated with grease or a bituminous material before placing them in the formwork to prevent them from becoming bonded to concrete.

Advantages: Prestressed concrete has the following advantages 1. Since the technique of prestressing eliminates cracking of concrete under all stage of loading, the entire section of the structure takes part in resisting the external load. In contrast to this, in reinforced concrete, only the portion of the concrete above neutral axis is effective. 2. Since the concrete does not crack, the possibility of steel to rust and of concrete to deteriorate is minimized. 3. Absence of cracks results in higher capacity of the structure to bear reversal of stresses, impact, vibration and shock. 4. In prestressed concrete beams, dead loads are practically neutralized. The reactions

required are therefore much smaller than required in reinforced concrete. The reduced dead load weight of the structure results in savings in the cost of foundations. The neutralization of dead load is of importance in large bridges. 5. The use of curved tendons and the pre-compression of concrete helps to resist shear.

6. The quantity of steel required for prestressing is about 1/3 of that required for reinforced concrete, although the steel for the former should have high tensile strength. 7. In prestressed concrete, precast blocks and elements can be assumed and used as one unit. This saves in the cost of shuttering and centering for large structures. 9. Prestressed concrete can be used with advantage in all those structures where tension develops, such as tie and suspender of a bow string girder, railway sleepers, electric poles, etc. 10. Prestressed concrete beams usually have low deflection.