Post-Tensioned cocrete floors sizing with funicular models

AUTHOR: Àlvar Diego Íñiguez
TUTOR: Lluís Gil Espert

ABSTRACT

Although until years ago, in the construction in general to our country, post-tensioning relegated almost solely to the scope of the civil work and in special to the construction of bridges, the new requirements imposed by the architecture to the structural design, the economic development of the country and the restlessness of some designers have made wake up, in the last years, the interest on the technique of the post-tensioned concrete floors with nonadherent tendons, like alternative to traditional forged of reinforced concrete. Of the advantages that display forged of post-tensioned concrete floors with nonadherent tendons respect to the traditional floors, it emphasizes that they allow to obtain greater free areas of pillars, considerably to reduce the structure depth and the dimensions of the laying of foundations, to diminish the crack problems and the limitation that the deformations introduce in the dimensions of the structural elements of the building and, finally, allows to increase the speed of execution.

In this Tesina a review of the state-of-the-art of this technique in all the aspects relative to history, the scope of application, types of post-tensioned floors systems with nonadherent tendons, the used materials and the advantages respect to the reiforced floor systems is made. Also, the general criteria of sizing appear proposed by diverse international organisms and diverse national authors dedicated to the study of the concrete, in relation to the treatment that makes the spanish norm.

On the other hand, the antifunicular analogy has been historically one of the first scientific methods used to demonstrate the stability of the constructions of factory work. The antifunicular analogy establishes the relation between the form of a catenary and the form of the line of of pressures that the balance of an arc forms. This analogy can be extended to the study of the stability of three-dimensional structures as the cupolas and to the study of structures formed by mesh wirings. In this study is the formulation of a catenary element that allows to simulate the behavior of mesh wirings and the foundations for the calculation by computer of networks appear funiculars and antifuniculars.

By means of a numerical application of calculation of funicular forms, that uses the mentioned formulation, analyzes the possibility of application of the funicular analogy of the loads for the calculation of post-tensioned concrete floors with unbonded tendons. This application allows the static analysis in three dimensions of structures formed by elements that only work to traction, like for example the prestressed cables of post-tensioned floors. So that the funicular analogy is applicable, it is precise that the post-tensioned type of is nonadherent, to assure that the mechanism of structural work is the operation to flexion and the analogy can be established arc-brace.

Also, the bases for a new methodology of design of this structural, alternative type are put to the traditional methodology, cradle in the Method of Compensation of the Loads. In order to do it, diverse examples of validation that go of simpler, to more complexes appear. The results of each example are confronted with the results obtained by means of the traditional analysis, to validate the new methodology.

The methodology of design applied in the validation examples allows automatically to know, in a cable submissive a determined load, the pair of values prestress force /excentricity that compensate this load and, in addition, of deducing of very simple way the law of equivalent moments and the law of secondary moments. Also it allows to know the traction the cable in each point and, therefore, to evaluate with exactitude the prestress losses. Finally, unlike which one becomes in the conventional analysis, in which an only tendon calculates and the result for all the tendons in that direction becomes general, the analysis as mesh wiring allows to model the real geometry of all cables and to find the tractions, is as it is the geometry of the floor.