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Cross Sections and Prestressing Forces Optimizations of Prestressed Concrete Beams

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Abstract

In many cases prestressed concrete structures are more advantages than ordinary reinforced concrete structures. However, designing prestressed concrete structures that fulfil the optimum criteria is not an easy task. This is because there is an interaction between the size of cross sections and prestressing force that has to be given to the structures. One method to design prestressed concrete members is the famous Lin's load balancing method, which is very simple, especially for one-span simple beams. For complex members, such as continuous beams, there will be a secondary moment due to the hyperstatic forces presence in the statically indeterminate structures. In addition, for continuous beam the smooth transition of the cable profile should be maintained in the middle supports that render the application of the load balancing method. In order to alleviate this difficulty, the use of moment coefficient-β method has been proposed.

Optimization of prestressed concrete structures becomes a challenging task for most of structural designers. This paper considers optimization procedures for prestressed concrete beams. For obtaining prestressing force, the moment coefficient method, which is the ratio of moment due to prestressing force divided by prestressing force, is used in the computation. In determinate structures this coefficient exactly is the eccentricity between center of gravity of the section and the center of gravity of the prestressing steel. However, in statically indeterminate structures, this ratio is not the same as the eccentricity; due to the presence of the secondary moments. This leads to the concept of the moment coefficient-β.

Recently optimization methods have received a considerably attention from the structural designers. These include size, shape and topology optimizations. The algorithms used to optimize the problems include particle swarm optimizations, genetic algorithms, and ant colony methods. In this paper real coded genetic algorithms (RCGAs) that have been successfully used in control system is utilized to optimize the cross sections and prestressing force of prestressed beams. One of the advantages of RCGAs is that it has the ability to explore the unknown domain that might be difficult to achieve by using binary coded. To show the effectiveness of the method, numerical examples are then carried out. The first example is a one-span prestressed concrete beam. In this case, the coefficient β equals to the eccentricity e. The RCGAs is used to obtain the optimum cross sections and the magnitude of the prestressing force. The second example discussed here is a three-span continuous beam. Although the beam is a statically indeterminate structure, it is not necessary to compute the secondary moment due to the hyperstatic force effect. This is because it has been included in the coefficient-β. Similar RCGAs are then used to optimize the cross section and prestressing force.