8th International Congress on Civil Engineering,
May 11-13, 2009, Shiraz University, Shiraz, Iran

OPTIMIZATION OF PRESRESSED CONCRETE FLANGED-SECTION BEAMS

Samer A. Barakat

Civil and Environmental Engineering Dept., University of Sharjah, P.O.Box 27272

sbarakat@sharjah.ac.ae

Abstract

A general approach to the single objective optimum (SOO) design of simply supported prestressed concrete flanged-section beams (PCB) is presented in this paper. The proposed approach incorporates all behavior and side constraints specified by the American Concrete Institute (ACI 318-05) code for prestressed concrete. Using the feasible direction method, a set of optimal geometrical dimensions, amount of prestressing steel, prestressing loses, and tendon profile are obtained. Several constraints are considered, including permissible tensile and compressive stresses at both initial and final stages, prestressing losses, ultimate shear strength, ultimate flexural strength, cracking moment, crack width, and the immediate deflection and the final long term deflection. A general SOO methodology is developed and solved by integrating PCB design with an automated design optimization package using the feasible direction method. The problem is formulated in general form so that introduction of specific requirements following from national codes is possible. The single objective function represented by the overall cost of the PCB in terms of concrete, prestressing steel, mild steel, and formwork- is minimized subjected to eleven constraints and four geometrical constraints. The design variables consist of six geometrical dimensions that shape the PCB cross section and one that represents the amount of prestressing steel. Numerical examples are presented to illustrate the application of the proposed approach to the SOO of PCB. The results consist of, but not limited to, the section dimensions, initial and final prestressing forces, prestressing losses, immediate and final deflections, active constraints, upper and lower bounds on the parabolic tendon profile and the total cost.

Keywords: Optimization, feasible directions, flanged-section, prestressed concrete.

1. INTRODUCTION

The purpose of the structural design is to develop a structural system in an optimal fashion in accordance with a set of predefined needs and accepted values. Due to increasing global competitive market, optimum designs are pushed to the limits of the constraints boundaries. The optimal decision is to choose an alternative, among the available ones, which will produce the best performance and compromise all considered factors.

Prestressed concrete design according to the ACI 318-05 [1] involves the combination of both allowable stress design and ultimate strength design. Also, in the current code practice, structural safety and serviceability requirements are ensured by applying appropriate safety factors. PC design process consists of proportioning the structure to satisfy the allowable stress requirements and then to modify the design to satisfy the ultimate strength requirements or Vice versa. The solution of this problem usually requires the use of iterative techniques due to the large number of nonlinear requirements (constraints) that must be satisfied. As a consequence, a practical and efficient SOO design philosophy should be adopted and implemented in profession practice of prestressed concrete beams (PCB) design.