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Controlling the deflection of Steel Cantilever Beam using pre-tensioning cable

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Abstract

Despite appropriate design of beams under bending and shear, the deflection of long steel beams usually exceeds the allowable range, and therefore the structural designers encounter challenges in this regard. Considering significant features of the cables, namely, low weight, small cross section, and high tensile strength, they are used in this research so as to control the deflection of beams, rather than increasing their heights, and obtain acceptable responses. In this study, for the first time, theoretical relation is developed to calculate the increase in pre-tensioning force of steel cables under external loading based on the method of least work as well as the deflection of steel cantilever beam with cable based on the virtual work method. Moreover, required cross-sectional area of steel cable has been calculated to reach allowable deflection in steel cantilever beam with cable. To verify the theoretical relations, the steel cantilever beam is modeled in the finite element ABAQUS software without cable and with cable. The obtained results show that the theoretical relations can appropriately predict the deflection of cantilever beam with cable. Furthermore, in bending moment diagrams of cantilever beam without cable and with cable, if the cable leads to neutral axis at free end of the cantilever beam, the bending moment of cantilever beam with cable will not increase compared to that of cantilever beam without cable.

Keywords:

Deflection, Steel cantilever beam, Cable, Pre-tensioning

1. Introduction

Cables as important components of structure are materials which can tolerate the tensile force and generally increase the stiffness and bearing capacity of the structure (Razavi and Sheidaii 2012). Nowadays, the cables are increasingly used in the structures. Hou and Tagawa (2009) applied cable-cylinder bracing in the

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