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Finite Element Analysis and Optimization of Steel Girders with External Prestressing

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Abstract

Optimization is a process through which the best possible values of design variables are achieved under the given of constraints and in accordance to a selected optimization objective function. Steel I-girders have been used widely in different fields, which are generally fabricated by connecting two plate flanges, a flat web and a series of longitudinal or transverse stiffeners together. The use of steel girder with external prestressing has been used in many countries as a means of strengthening bridges. The purpose of this paper is to develop a finite element model for the optimization of a steel girder with external prestressing. The ANSYS finite element software package was used to find the optimum cross section dimension for the steel girder. Two objective functions are considered in this study there are optimization of the strain energy and total volume of the girder. The design variables are the width of top flange, the thickness of top flange, the width of bottom flange, the thickness of bottom flange, the height of the web, the width of the web and area of prestressing tendons. Two type of steel girder are considered there are steel girder without prestressing and steel girder with prestressing. The results for volume minimization shows that the optimum cross section for steel girder with prestressing smaller than for steel girder without prestressing.

Keywords: ANSYS; Finite Element; Optimization; Steel Girder; External Prestressing; Stiffener.

1. Introduction

The use of External Prestressing (EP) has been used in many countries since the 1950s as a means of strengthening bridges or rehabilitatingiexisting bridges. It has been used to provide an economical and efficient solution for a wide range of bridges. The technique is growingiin popularity because of the minimalitrouble to traffic flow and the fast of installation. The principle prestressing is theiapplication of an axial load together with a hogging bending moment to increase the flexural capacity of a steel girder. It can also have a beneficial effect on shearicapacity [1].

EP is a prestress presented by wires placed outside of a structural member, the wires linked to the structural member through end-anchorages, deviators and profiled along the span at strategically located low and high points.

Steel Girder (SG) prestressed with high strengthiexternal wires have validated numerous advantages as compared with normal SGs. This benefit are extend the range of elastic performance previously yielding for the SG and increase in ultimate capacity of moment of SG. The stresses can then oppose the moment generated by theiloading. The amount of steel utilized in building, depended on yield strength alone, can.be decresed.by the use of wires with high-strength, thus decreasing the total cost of construction.

EP of girder oricomposite beams is generally used in bridge engineering and frequently to strengthenlexisting structures [2]. This practice can be applied to one span or continuous SG and reinforced concrete deck bridges. It is

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