Ultimate strength interaction of stiffening steel box girder in cable-supported bridges

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Summary

Wide flange box type steel cross-sections are widely adopted as stiffening girders in cable-supported long span bridges due to their relatively light self-weight, superb torsional rigidity and aero-elastic performance. Those stiffening girders are supposed to resist externally applied bending moment as well as compressional forces in longitudinal direction transmitted from inclined cables. Ultimate strengths are interactively determined as ultimate flexural strength is affected by applied axial compressive forces and ultimate compressive strength is affected by applied flexural moment. Effect of strength interaction between bending and compression are investigated for wide flange type steel box girders in this study. Wide flanges are stiffened with U-shaped stiffeners that are also called U-ribs. To evaluate the interaction effect, nonlinear incremental analysis techniques are fully utilized for hypothetical numerical models. Initial imperfections and residual stresses are also incorporated in the analysis. Strength interaction curves are compared with existing codes for the purpose of practical strength design for wide flange steel box girders in cable-supported bridges.

Keywords: wide flange type steel box girders; ultimate strength interaction; stiffened plates; U-rib; effective width; cable-supported bridges.

1. Introduction

Wide flange type steel box girders have been widely used in cable-supported bridges because they are effective in long span by reducing the dead weight. Deck or bottom plate on this type girders are usually stiffened by closed stiffeners rather than open type ones as former have high performance on wheel load distribution and local rigidity [1]. When box girders are under external loads, the main load components are bending moment and axial compression. In resistant mechanism, flexural strength is affected by applied axial force in compression, and similarly axial compressive strength is affected by applied bending moment. So, one of the most important steps in general design procedure for box girder is to evaluate these interaction effects. For prerequisites for strength interaction, pure bending or pure compressive strength have to be calculated in advance. In simple design concept, flexural failure may assumed to occur when the extreme fibre flange stress reaches the ultimate strength in compression flange or the yield strength in tension flange. Ultimate flexural resistance for a box cross-section can be calculated as a product of ultimate stress in extreme fibre and elastic section modulus of the box cross-section [2]. Elastic section modulus are usually calculated based on the effective section considering shear lag effect. AASHTO LRFD Bridge design specification [3] or BS 5400 code [4] etc. consider the interaction effect between bending and compression as linear relation. In other words, sum of relative bending and compressive

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