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General Design of Hollow RC Sections under Combined Actions

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1 Abstract

Hollow reinforced concrete sections are consistently considered the preferred solution for medium to large sized bridge projects due to its structural efficiency and the large material savings associated with it.

To fully harvest the structural capacity of hollow sections exposed to combined actions it is necessary to leave behind the simplicity of treating the verification of structural adequacy for normal stresses (beam theory) separately from that of shear stresses (diagonal truss model) and instead fully exploit the advantages of choosing more efficient stress distributions. By exploring the vast possibilities of other statically admissible systems using optimization routines, one will find that longitudinal reinforcement near the neutral axis can be utilized much more efficiently.

In addition, by adhering to the interdependency constraints between normal and shear stresses a much more precise picture of the actual service stress state can be determined. There is therefore the need for a one-step, automated design tool capable of addressing such verifications holistically.

In this paper the theoretical basis and a free to use open-source design tool is presented, allowing for easy access to highly optimized designs capable of pushing the materials to their limits.

Keywords: shear; hollow; design; plasticity; bridge; optimization; membrane.

2 Introduction

The design of large reinforced concrete (RC) hollow sections is recurrent in medium to large sized bridge projects.

Hollow sections are consistently considered the preferred solution for substructure members (piers, towers or columns) and for bridge decks (e.g. prestressed box girders) due to its structural efficiency and the large material savings associated with it.

One of the main challenges with contemporary bridge design is the increasing difficulty in the immediate identification of critical loading scenarios or locations. In fact, as code requirements evolve one needs to account for a growing number of load combinations in the design. In addition, as aesthetic considerations become more predominant, the shapes of structural members become more complex. This challenge is

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