Shear design of composite columns with sheet metal sections

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Abstract

Composite columns offer an efficient solution for vertical elements in high-rise buildings through high load bearing capacities and fire safety. Until now, such sections have been constructed with either rolled or solid profiles as core element. Residual stresses of such core profiles often cause inefficient use of material due to the reduction of yield strengths. This paper presents a new form of composite columns consisting of metal sheets as core profile with optimized shear connection. Advantages are expected from a reduction of residual stresses due to smaller thicknesses of each partial core as well as adjustable flexural rigidity settings, as shear connecting elements can be installed locally where needed. Deployment of high strength steel helps increasing the bearing capacity significantly.

Keywords: column, composite construction, high-rise buildings, high-strength steel.

1 Introduction

Construction of multi-storey buildings is characterized by high vertical loads and high demands regarding fire resistance. Composite columns, consisting of concrete-filled tubular steel sections with core profiles, generally fulfil those requirements. At the same time, they are characterized by a slender design. Single solid steel profiles as core profile within the tubular hollow section are to be seen as state-of-the-art. Current research developments make use of several separate solid core profiles or a second hollow section, confined with concrete. [1–5]

Drawbacks of conventional sectional design are being found in the high residual stress distribution of large diameters of solid core profiles which provoke a high reduction the yield strength [6]. Additionally, significant equivalent geometric imperfections need to be considered that weaken the section's load bearing capacity.

Currently, sections manufactured from separate steel sheets are fully welded over the whole sections' length to ensure longitudinal shear transfer. This results in high residual stresses due to the welding process and inefficient section design with high labour efforts.

Within this paper, an innovative approach of sectional design is being followed. As core profiles, steel sheets in form of lamellae are deployed within a steel hollow section. For shear transmittance within the core section, only local connections of the sheets are provided in form of bolts and welding seams. Consequently, less material imperfections and reduction of yield strength must be considered due to smaller partial sections. Also, the bending stiffness can be influenced individually, making use of local connections.

In addition to the innovative section design, high strength steel grades are deployed: yield strengths up to 960 MPa for the core's section, 890 MPa for the tubular section. As there are currently no regulations for the use of such steel grades within European regulations [7], it is the authors' aim to contribute empirical results from numerical and