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Component method in the strength evaluation of cold-formed steel joints

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Abstract

Nowadays, there is a growing tendency in the use of cold formed constructions, which may be explained by good strength to cost ratio. Thus, the goal of this paper is to investigate the strength of cold-formed steel beam-to-column bolted gusset-plate joints. In the paper the model of moment resistance of such joints based on the component method is presented. The calculation of resistance of steel components is based on EN 1993-1-8 and EN 1993-1-1. Two types of gusset plates are investigated: I-shape and T-shape. The developed model is well in line with the full-scale experimental results.

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Keywords: Cold-formed steel joints; beam-to-column joints; moment resistance of joint.

1. Introduction

Cold-formed thin walled sections are widely used as bearing structures in construction sites because of good cost to bearing capacity ratio, fast and easy erection. In most cases thin walled sections are used as purlins, steel trusses and for light weight portal frames. There is a wide variety of cold formed sections (such as Z-sections, C-sections, sigma-sections, omega-sections, etc.) and connections. Cold formed sections can be connected using gusset plates and bolts or directly using bolts [1, 2], screws [3], mechanical clinching [4] and welds.

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In the recent years, researches on thin walled sections have focused on beam-to-column connections with gusset plates [5-11]. Wong and Chung [5] executed beam-to-column sub-frame tests with different configurations of the gusset plate connections. The authors have been investigating the influence of gusset plate thickness, the chamfer presence and the distance between bolts on the strength and stiffness of connections using experimental results. It was found that the geometry of gusset plate has huge influence on the behaviour of the connection. Yu et al. in their job [6] presented semi-empirical design method to calculate rotation stiffness of gusset plate connection. Sabbagh et al. [7-9] executed the tests of the beam to column connections with gusset plate connections under cyclic loads to take into account the different beam's stiffeners. The optimum configuration of stiffeners was proposed. In Bucmys and Daniūnas's paper [10] the stiffness investigation using component method have been presented. The study of papers showed that it is lack of such joint strength investigation using component method.

The goal of this paper was to present a moment resistance calculation model for beam-to-column bolted gusset plate joints (Fig. 1). The resistance of components is determined according to EN 1993-1-3 and EN 1993-1-1. Moreover, another task is to investigate gusset plate behavior using experimental test results.

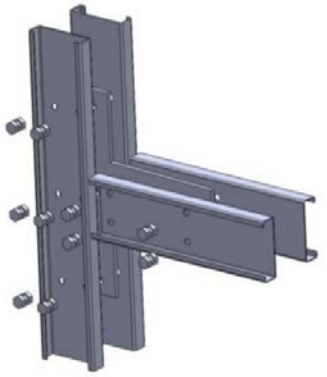

Fig. 1. The exploded view of the joint under analysis.

2. The model of joint moment resistance calculation using component method

Component method is applied for cold-formed steel beam-to-column joint, as shown in Fig. 1. It is convenient to separate the joint into three springs [10]. The design moment resistance $M_{j,Rd}$ of the presented beam-to-column joint depends on bearing capacities of these springs:

- Beam bolt group in bending and shear $M_{bbg,Rd}$;
- Column bolt group in bending and shear $M_{cbg,Rd}$;
- Gusset plate in bending and shear $M_{gp,Rd}$

- Beam and column sections in bending $M_{c,Rd}$.

The design bending moment resistance depends on the weakest spring of the joint:

$$M_{j,Rd} = \min(M_{bbg,Rd}; M_{cbg,Rd}; M_{gp,Rd}; M_{c,Rd}) \quad (1)$$