Characterisation of the load-bearing behaviour of Lockstud systems based on experimental investigations

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ABSTRACT

The joining technology Lockstud system combines the advantages of a bolt thread for making a tapped thread joint and the advantages of a lockbolt. On the tapped thread joining side, the bolt has a metric ISO thread. On the assembly side, the bolt has a grooved geometry like lockbolts of type A, B and C. This article publishes results on the mechanical-technological properties, the assembly behaviour and the load-bearing behaviour under static and fatigue load for non-preloaded Lockstud systems of nominal sizes M16 and M20 (strength grade 10.9).

KEY WORDS: Lockstud, detail category, fatigue resistance, Eurocode 3, assembly preload, load-bearing behaviour

INTRODUCTION

Although high-quality connections can be realised with the classic bolted connection as a through-bolt or tapped thread joint, their use is associated with some significant disadvantages. The main disadvantage is the process-related scattering of the preload in torque-controlled assembly, which, combined with fluctuations in the thread and under head coefficients of friction, leads to assembly uncertainties. Due to insufficient initial preload and subsequent fatigue loading, self-loosening of the bolted connection can occur, which often results in damage to bolts in practice. (Wiegard et al., 2007; Stranghöner et al., 2018; Friede, 2010; Hasselmann and Valtinat, 2002; Glienke et al., 2015) Therefore maintenance intervals are prescribed immediately after commissioning as well as during operation for fatigue loaded bolted connections in various areas of application in structural and mechanical engineering. (Deutsches Institut für Normung, 2019; DNV GL SE, 2021).

Lockbolt systems according to Technical Bulletin DVS/EFB 3435-1 (German Welding Society and European Research Association for Sheet Metal Working, 2021) and Technical Bulletin DVS/EFB 3435-2 (German Welding Society and European Research Association for Sheet Metal Working, 2017) consist of a lockbolt made of carbon steel and an associated collar. Compared to classic bolted connections, these are characterised by a special suitability for maintaining the preload over the service life. (Ebert, Glienke and Dörre, 2017; Matos, Mohammadi and Rebelo, 2017; Mohammadi, Matos and Rebelo, 2017), by a high level of assembly safety due to the friction- and torsion-free tightening process, (Glienke and Wanner, 2012; Glienke, 2013; Stranghöner et al., 2019), a higher fatigue strength under concentric and eccentric load compared to structural steel bolts (system HV according to DIN EN 14399-4 (Deutsches Institut für Normung, 2015a)) (Missoum et al., 1997; Glienke et al., 2015; Schwarz et al., 2018) and an effective securing effect for transverse loads above the theoretical threshold (Schwarz et al., 2017, 2020).

Responding to the mentioned requirements, a studbolt is presented, that merges the advantages of a bolt thread for making a tapped thread joint and the advantages of a lockbolt system. This is called the Lockstud System (LoS). On the threaded side, the bolt has a metric ISO thread according to DIN 13-1 (Deutsches Institut für Normung, 1999). On the assembly side, the bolt has a groove geometry, as is known from lockbolts of types A, B and C according to Technical Bulletin DVS/EFB 3435-2 (German Welding Society and European Research Association for Sheet Metal Working, 2016).

Fig. 1: Schematic assembly process for the Lockstud system (type C) for one-sided accessibility

This characteristic offers the potential for mechanically maintenance-free connections. Due to the torsion-free assembly of the Lockstud systems, a preload level with low scatter is achieved. Together with the formed collar, mechanically joined connections can be secured against