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Research on fatigue cracks in composite dowel shear connection

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ABSTRACT

Last year, extensive research was conducted on a modern type of continuous shear connectors – the composite dowel PreCo-Beam (2001) [1] and innovative composite constructions were designed and built. As this shear connection is to be applied mainly for bridges, problems concerning fatigue behavior arise Berthellemy et al. (2009) [2]. Complicated stress distribution from external loads in steel dowels combined with different manufacturing technologies and resulting eigenstresses make the stress patterns in steel dowels very complex, and the problem of fatigue cracks even more complicated. This study presents investigations undertaken after completion of the PreCo-Beam project [1], which is a part of research to be conducted years 2009–2011 at Wrocław University of Technology.

General information on an approach to estimating the fatigue resistance of composite dowels is presented, focusing on a description of stress analysis in steel dowels, and the impact of the manufacturing method on fatigue lifespan. The background to a detailed fatigue numerical analysis is presented, as are the initial results obtained from numerical simulations. These are verified against the background of experimental tests results.

1. Introduction

A modern type of continuous shear connection, the composite dowel, is an increasingly promising solution for composite beams (Fig. 1). This innovative shear connection is implemented in a construction method where the connection between the halved steel girder and concrete is provided by steel dowels manufactured using a special cutting line of the web of a steel section or plate. Different shapes of cutting line are possible. For the purposes of this paper, a puzzle shape (Fig. 1c) and clothoidal shape (Fig 1d) are presented-the first shape (PZ) was strongly investigated and tested, and so it is a good reference for scientific investigations, and the second shape (CL), which was ultimately developed, was implemented for industrial production. Contrary to the standard solution using welded studs (Fig. 2a), an upper flange is not needed for completion of the composite girder (Fig. 2b), and it is thus possible to implement economic and robust prefabricated steel–concrete composite girders [3].

Composite dowels have developed rapidly over the last few years, especially in the course of the European PreCo-Beam research project [1]. Today, primary design rules are available [1,3] together with efficient manufacturing technology [2]. The manufacture of steel dowels is fully automatic (Fig. 3), contrary to the typical solution employing welded studs (Fig. 4), where additional manpower is needed. Therefore, economically, composite dowels are a very attractive solution for bridge engineering and being used increasingly often (Fig. 5), especially for spans constructed over railway lines (Fig. 5b and c) where rapid production of the superstructure is especially important.

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