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Abstract

Helically shaped fasteners, as structural ties, were first developed in 1984. Their innovative helical design proved to be very efficient and structurally viable in numerous structural applications in masonry and stone construction. Over the years, their uses widened to include amongst others crack stitching, warm roof batten fixing and creating masonry lintels. Following the understanding that helically shaped fasteners could have considerable potential providing highly efficient jointing systems and offer a number of advantages in structural applications for connecting timber to timber as well as timber to masonry/concrete a research programme was developed.

By conducting a review on the state of the art of timber jointing, the numerous methods for structural timber connections and the range of parameters that can influence the resistance of such joints were highlighted. Such a review allowed the development of an extensive experimental programme design to characterise helically shaped fasteners as structural timber connectors.

The mechanical properties of helically shaped fasteners were first investigated and compared to common timber connectors. In accordance with the relevant European and British standards, the investigation showed that helically shaped fasteners exhibited a very ductile behaviour compared to other common fasteners. However the design equations of Eurocode 5, which were developed for common timber fasteners, did not accurately predict the characteristic values of helically shaped fasteners. Consequently, specific design equations were developed for predicting the characteristic helically shaped fasteners' yield moment and embedment strength.

The innovative helical shape of helically shaped fasteners was designed to increase the bonding between the fastener and the substrates to connect. Hence, the axial resistance of helically shaped fasteners in timber was extensively investigated. The results showed that the helical shape of the fasteners gives them high axial resistance in timber. The investigation showed that numerous parameters affected the withdrawal resistance of helically shaped fasteners, and that they could be combined in semi empirical models to predict the resistance and behaviour of helically shaped when axially loaded in timber.

The investigation was also focused on the lateral shear resistance of timber connections with helically shaped fasteners loaded in single and double shear. The results showed that the connections exhibited very ductile behaviour while reaching similar resistance to common timber connectors. As a result semi empirical models were developed to predict the lateral shear resistance and behaviour of timber connections with helically shaped fasteners.

In addition to timber connections, the research also examined the use of helically shaped fasteners in timber to concrete connections for use as sole-plate fixing and timber-concrete composite flooring systems.

The research showed that the helically shaped fasteners have considerable potential for use in a wide range of timber connection systems as they provide a unique solution combining strength, flexibility, durability and holding power. The study also developed an in-depth understanding of the factors that influence their strength and stiffness properties. A series of semi-empirical models were developed to predict the performance characteristics of helically shaped fasteners, in withdrawal and lateral shear, which provide powerful analysis-design tools for architects and engineers as they predict the connection behaviour, up to failure loads, with good accuracy.