

# The Development and Application of a New Connector Type for Use in Timber Structural Systems

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Figure 1: Example of Helifix fastener.

## Introduction:

Helifix connectors, which have a unique helical design made of austenitic stainless steel, have been used since 1984 as efficient, economical, non-disruptive wall ties and masonry repairs or for connecting timber frame to masonry cladding. Preliminary studies have shown that they can also provide a simple but highly efficient and reliable fixing system for use as a main connector in structural timber. This research aims to utilise their advantages and performance for use in a variety of structural timber connection systems, detailing the tests performed to study their performances and structural behaviour.

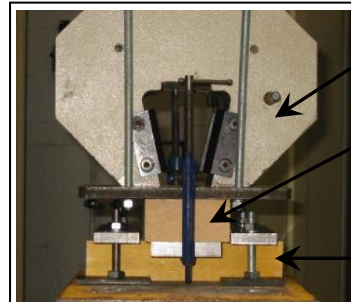


Figure 2: Withdrawal tests set up.

## Research program:

Helifix fasteners were tested in direct withdrawal along with 4.50mm round wire nails and 3.00mm helically threaded nails, in accordance with BS EN 1382:1999<sup>(1)</sup>, to compare their pull out behaviour and resistance with common nails. The fasteners were tested perpendicular and parallel to the grain. The withdrawal strength, W.S. (in N/mm<sup>2</sup>), of the fasteners was calculated as follow:

$$W.S. = \frac{F_{max}}{d \cdot l_p}$$

$F_{max}$ : maximum withdrawal load, N.  
 $d$ : diameter of the fastener, mm  
 $l_p$ : depth of penetration, mm

## Results:

The results show that Helifix fasteners have much greater maximum withdrawal loads than common nails, perpendicular and parallel to the grain. They also show higher withdrawal strength than common wire nails, but the withdrawal strength achieved with helically threaded nails is equivalent to Helifix. In end-grain Helifix fasteners show greater results than common nails.

The fasteners in direct withdrawal perpendicular to the grain showed a flattening of the helix. Pulling apart the two timber members caused unwinding of the fasteners. In end grain the timber fibres caught in the helix of the fasteners sheared off.

Helifix fasteners showed a much ductile behaviour with the maximum withdrawal load attained between 7 and 14 mm, in comparison with common nails attained between 0.3 to 0.8mm.

Fastener type	Diameter, mm	Direction of grain	Withdrawal load, N	Withdrawal strength, N/mm <sup>2</sup>
Round 4.50mm	4.50	perpendicular	782.45	3.90
Threaded 3.00mm	3.00	perpendicular	831.93	6.22
TimTie 4.50	4.50	perpendicular	1632.23	8.19
InSkew 600	6.00	perpendicular	1799.24	6.72
StarTie 8	8.00	perpendicular	2241.48	6.33
StarTie 10	10.00	perpendicular	3169.60	7.13
Threaded 3.00mm	3.00	parallel	482.18	2.78
TimTie 4.50	4.50	parallel	778.47	3.46
InSkew 600	6.00	parallel	1102.98	3.68
StarTie 8	8.00	parallel	1701.34	4.24
StarTie 10	10.00	parallel	2292.95	4.59

Table 1: Withdrawal tests results.

## Other factors investigated:

Further tests were performed to investigate the factors influencing withdrawal resistance and behaviour of Helifix fasteners. They were:

- ▣ The effect of the pilot hole,
- ▣ The effect of the wood density,
- ▣ The effect of the depth of penetration,
- ▣ The effect of the angle of penetration to the timber grain.

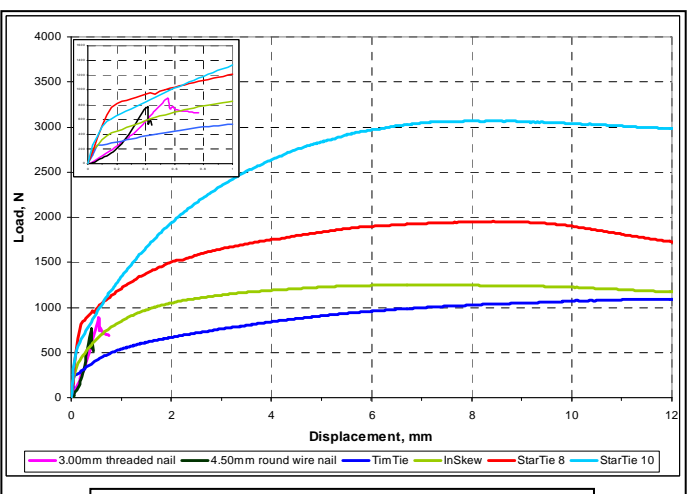


Figure 3: Withdrawal curves for Helifix and nails.

## References:

- 1: BSI, BS EN 1382:1999 "Timber Structures – Tests Methods – Withdrawal Capacity of Timber Fasteners".
- 2: Porteous A. & Kermani A., "Fully Overlapping Nailed Joints with Steel Gussets in Timber Structures", ASCE Journal of Structural Engineering, Vol:131, May 2005, 806-815.