Repair techniques in different regions of the world are as varied and diverse as the construction techniques peculiar to each region. It is therefore somewhat of a success story when British concepts resulting in British design and British manufacturing is used to export repair products and systems to all corners of the globe. Helical fixing technology is one of those successes.

HISTORY.

The innovation of hammer driven helical fixings originated from a GKN/Timber Research and Development Association (TRADA) programme undertaken in the 1970's. The study addressed the effect of timber shrinkage, due to fire, on the integrity of conventional fixings once the clamping effect of the head had been lost. The project delivered a patented hi-fin helical dowel that interlocked with the fibres of the timber along the full length of the helix.

The project leader was TRADA's Chief Architect John Ollis who had wide and diverse ideas of how the new helical technology could be used in new construction and in renovations. John procured the patent from TRADA and proceeded to explore the commercial prospects for helical products in the construction industry. Henry Ollis, from a production engineering background, joined his father in the early 1980's and provided the engineering capability to design unique products and novel manufacturing methods and applications for Johns' innovative helical concepts. Together they researched, tested, developed and patented a wide range of fixing technologies using extrusions, drawn tubes and wire sections.

The fixings contained large work hardened fins extending radially from an unhardened core to form a slackly pitched screw-like anchor or reinforcement member. When subjected to a series of axially applied impact blows the angular face of the helical fins react against the host material initiating controlled self-rotation of the fixing as it cuts a spiralling penetrative path.

As the Pioneers and Inventors of the helical fixing concept, the Ollises founded **Helifix Ltd** in 1984, to exploit their patented technology under licence. Their interests in Helifix were sold with Helifix being independently licensed to manufacture under the Ollis's two patents, EP0150906B1 and EP0171250B1 in1986. Subsequently Target Fixings Ltd., (U.K.), and Brutt Helical Kft were also licensed. any helical stainless steel ties and reinforcement wires bear the Ollis's Pat. No. 171250. This is a European Patent - No EP0171250B1, which had a priority date of 31/07/1984 and expired in July 2005.

The Ollises continued to pioneer and develop new products, repair systems and manufacturing techniques and in the mid - late 1990's formed the Thor Helical product development team to progress and nurture new concepts, techniques and innovations.

Through Thor Helical the technology has progressed and adapted, producing an expanded range helical fixings with highly consistent characteristics, using precision engineering to tolerance levels that have not previously been achievable. This comprehensive second generation range of hammer-driven helical fixings, wall ties, piles and anchors have been designed to suit a variety of construction and repair applications, and patents have been filed on many products, manufacturing methods and building applications, as one innovation has followed another.

PRINCIPLES OF HELICAL FIXING TECHNOLOGY.

The concept of helical fixing technology is based on the peaks and troughs of the helix becoming interlocked with the host material and acting upon the hosts cylindrical shear resistance at the notional circumscribed periphery of the helical fins.

The ability of a helix to physically interlock with mating substrate delivers a mechanical connection that exerts no expansive stress and is not dependant on friction or adhesion.
When one building element is helically fixed to another and the composite subjected to an axial load, torsion (a rotational tendency) is transmitted to the helical member via its angular face at one connection. This torsion is resisted by an equal and opposite reaction of the helical member at the other connection, acting in effect like a torsion spring and providing a unique elastic yield characteristic to avoid catastrophic or sudden failure.

This equal and opposite reaction predisposes the helical section such that if fixed elements are pulled apart or compressed towards each other the helix becomes rotationally stressed. The resulting torsion enables the helical fixing to progressively accumulate imposed loadings, which are evenly imparted and distributed into the substrate along the full length of the helical anchorage.

These spring-like characteristics give significant benefits when the highly deformed helical profile is embedded in grout, in that the elastic torsion behaviour binds with the grout into microscopic yielding composite along the length of the helically grouted unit to accommodate normal cyclic movements yet provide resilience against more severe building failures.

REPAIR APPLICATIONS.

Remedial Wall Ties & Masonry Pinning Systems.

The requirement to provide retrospectively fitted wall tie systems is well known. A large variety of systems are available to re-tie buildings that have suffered from corrosion of the original tie installation or where insufficient ties were fitted during construction.

Helical wall tie systems comprise a range of stainless steel hammer driven ties, chemically grouted ties and a combination of the two.

The 'Decision Tree' in BRE Digest 329 identifies the driven helical ties as being the only fixing type that can be selected for use in any particular situation, irrespective of substrate, its compressive strength or for the requirement of a tie to maintain performance in the event of a fire.
Proven through independent testing programmes and 20 years of service use, hammer driven helical fixings can be used in a wide variety of construction materials including timber, brick, block and concrete.

Manufactured with '**precise pitch'** technology to tolerance levels that have not previously been achievable, second generation helical ties are axially driven into masonry elements, usually via pre drilled pilot holes. The work-hardened fins cut a precise and seamless spiral path into the host substrate providing an accurate and tightly mating helical interlock. Balanced in profile, stiffness and pitch to optimise ease of driving and improve reliability second generation helical ties provide a highly engineered, yet simple and user-friendly, alternative to earlier product designs. Reliability and consistent performance are combined with rapid and cost effective installation rates.

The versatility of helical ties facilitates their use where a grouted connection is required. The hi-fin/low trough design provides excellent distortion and maximises surface contact area to enhance the performance of bonded connections.

BRE Digest 401 details sampling rates for carrying out pre-contract and in-process performance testing and should be used to determine minimum project specific performance criteria for such tensile proof loads.

Retrofitted Masonry Reinforcement

Since the early 1990's the remedial industry has been developing methods of repairing distressed masonry by installing bed joint reinforcement into existing walls for the purpose of crack repair, Increasing flexural strength of masonry and beam creation to combat the effects of lintel failure and localised ground movement.

The production techniques used in the manufacture of stainless steel helical ties and reinforcement wires provides a 2 fold increase in ultimate tensile strength when compared to stainless steel rebar and a 7 fold increase when compared to wound spiral plate.

Lengths of helical crack stitch wire are grouted into raked out slots and used to tie across cracks in masonry. The highly deformed helical profile maximises bonding characteristics when the wires are embedded in grout, providing excellent compressive and axial strength along the full length of the helically grouted unit.
Combining these strengths with the elastic yield characteristics of the wire, the composite unit is utilised to distribute imposed loads along the full length of the reinforced zone to fully reinstate the structural integrity of distressed masonry and provide resilience against further cracking.

Where cracking has been caused by a failure in the support (i.e. failed arches, removal and replacement of structural windows with non-structural UPVC or localised subsidence) retrospective masonry reinforcement can be used to enable the masonry to behave as a beam.

Engineering input, (either on a project specific basis or in the form of factored product specific load tables), **must be used** to establish the load carrying capacity of a beam given a known span between supports and a **measured horizontal shear resistance** of masonry within the reinforced beam.

By reinforcing two separate mortar beds, each with a pair of helical reinforcement wires embedded in high strength proprietary grout, the retrospective masonry girder beam is created. The reinforcement and the two surrounding brick courses, which contribute to compressive strength, form chords that represent the upper and lower flanges of a beam, the un-reinforced masonry between the chords representing the web.

Earth Anchor & Piling Systems

The helical fixing concept, having been successfully applied to specialised nail, wall tie and reinforcement products and applications, has been further advanced by the Thor Helical product development team and applied to heavier civil engineering uses.

An archetype helical ground anchor was first used and tested as a piling system for house construction in 1996 under the guidance of the BRE. And has been used on many occasions to provide the known points of support for the helically reinforced beams.

The helical earth anchor comprises a copper helical profile with an effective 80mm circumscribed diameter, stiffened by triangulation and incorporating a hard driving point.

The anchors enlarged helical lead section interlocks with the ground, whilst the trailing circular copper extension tubes provide a slip plane within desiccated layers. The helical faces emit planes of stress at tangents along the full helical embedment length, which serve to optimise performance at relatively shallow depths. The build up of load upon the anchor gives a reaction by which an accumulative cone of stress is imparted into the ground, the helical troughs limiting deflection under load. The helical form provides an even distribution of load along its full length, acting upon the cylindrical shear resistance of the ground at the notional circumscribed periphery of the helical fins.

As the helical interlock action operates axially in either direction, the versatility of the helical earth anchor provides opportunity for use where tensile resistance is required, for instance to tie back earth retaining walls.