



Sole stitching in a groove.

CREDIT: CHURCH & CO (FOOTWEAR) LTD

Footwear Fundamentals

STITCHING SOLES CAME FIRST

Of all the methods that are now available for attaching soles to lasted uppers, the oldest by far is using thread to produce a mechanical join. Until the advent of modern adhesives some sixty years ago, it still offered the most flexible and reliable results over the greatest range of footwear types. Threads therefore evolved in a wide variety of sizes, constructions and raw materials, each suited to a particular type of shoe. Thread is still essential for sole attachment in several key footwear constructions, so it is useful to understand the basics that lie behind this most traditional aspect of the shoemaker's art.

Up until the late 19th century, most shoes were made by the hand welted process, whereby a strip of leather was sewn through the lasted upper beneath the edge of the last and a rib that had been formed on the underside of the insole. A sole was then sewn to the strip, all operations taking place with the last still in place. The construction was strong and also easy to repair as the sole could be replaced without damaging the rest of the shoe. Mechanised, it became the Goodyear process, which is still

used to produce the very best quality men's footwear.

The threads used for any type of sole attachment today, have their origins in those developed for Goodyear welted and it is extremely important that the correct type of thread is selected for specific applications. These heavy threads are made from various natural and synthetic fibres, each of which produces a thread with its own characteristics. If a combination of fibres is used, then a mix of properties will result depending on the proportions used. The four main types are as follows.

Linen – the traditional choice for welted footwear, this thread is made from the flax plant, which produces strong fibres with low extension. It was for many years thought the best solution for stitching heavy leather, where seam tightness is essential. Most linen threads are treated with a rot proof solution to protect the fibre from biological attack and can be pre-waxed by the thread supplier or by passing it through a wax pot on welt sewing and sole stitching machines.

CF polyester – this thread is made from a 100% synthetic material whose individual fibres are many miles in length in exactly the same way as those for stitching uppers. These continuous filament threads (*Figure 1*) provide high levels of strength and flexibility which makes them suitable for a wide range of sole stitching applications.

Spun polyester – in this instance (*Figure 2*), staple fibre lengths are used and strength depends on the length of the staple fibre and degree of twist introduced when the fibres are spun into yarns. Stitch-ability is generally good and they also offer a natural appearance.

Core spun polyester – this thread is produced for welt sewing and has been designed to achieve the optimum strength ratio of a continuous filament thread allied to good stitch-ability and the appearance of linen. Individual yarns are made up of a continuous filament polyester core, with an outer protective sheath of wrapped staple fibres, usually composed of cotton.

Figure 1 – Continuous Filament Yarn.

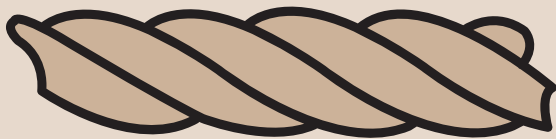
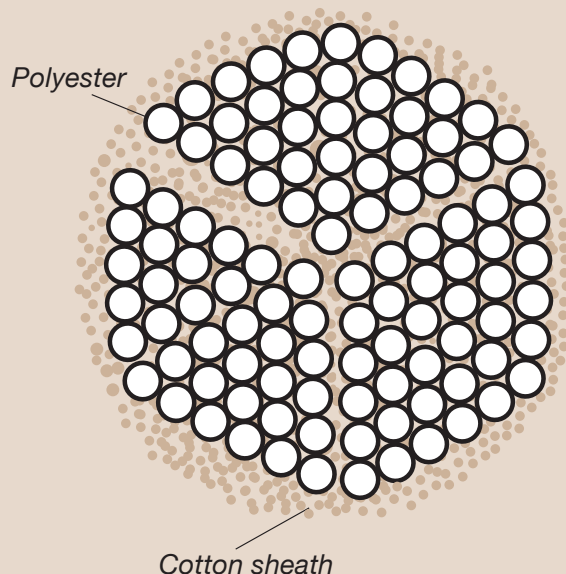


Figure 2 – Staple or Spun Fibre Yarn.



Figure 3 – Cross-Section View - Core Spun Polyester.



CONSTRUCTIONS

Whatever the fibre type, most heavy stitching threads are made up by either twisting or braiding a number of threads together. Careful control over the degree of twist or pick density is essential. Threads with too little twist or picks may fray or break and have poor control during sewing. Threads with too much twist and pick density have a tendency to snarl or knot - referred to as 'twist liveliness'. The twist action must also suit the action of the stitching machine.

Braided threads can be used on most machines and are also easier to work with as they do not untwist and therefore throw a more consistent loop. This means a braided thread gives a more uniform stitch appearance in difficult sewing operations and offers greater abrasion resistance as the filaments cannot separate. The centre stroke of the S or Z coincides with the direction in which the fibres or yarns appear on the surface (*Figures 4 & 5*).

The braid construction is produced by an identical method to that used, in braiding hair. Whichever substrate or construction is used however, it is essential that the threads

Figure 4

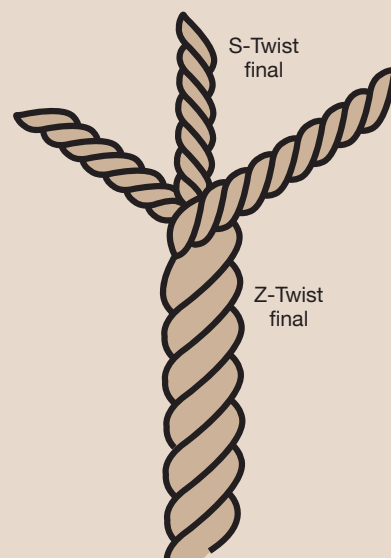


Figure 5 – Left or Z-twist and Right or S-twist.



Figure 6 – Braided Thread.



chosen have the correct technical properties to ensure good stitch-ability, a consistent and balanced lock position and an optimum seam quality for the particular footwear to be produced. Thread with inconsistent friction levels or excessive extensibility can lead to poor stitch balance with 'grinning' or gaping seams and premature separation of the sole during wear. (Figure 6)

INITIAL ELONGATION MODULUS

One particular area of heavy sewing thread technology that is perhaps often not as well understood as it should be but can prove expensive if ignored, is the initial elongation modulus. The various terms used to describe a thread's extensibility can be confusing, so what is the difference between elongation, elasticity and initial elongation modulus?

Elongation – if a length of thread measuring 100cm can be stretched to break at 110cm, it has 10% elongation. Elongation is simply the extent of stretch expressed as a percentage of the original length at break

Elasticity – this refers to the ability of a thread to stretch and recover to its original length. If a thread does this, it is said to have 100% elasticity.



Sewing in a welt. CREDIT: CHURCH & CO (FOOTWEAR) LTD

Initial elongation – it is far more meaningful to measure the extension of a thread under sewing conditions but, because of the complexities involved, it is considered to be virtually impossible. However, thread extension under certain known loads can be assessed and this is referred to as the elongation modulus. The importance of controlling the elongation at low loads helps to prevent stitching slip and is particularly important in welted shoes, where tightness of the seam is vital in order to prevent it from shearing.

Heavy sewing threads are used to produce two types of seam, a chain stitch or a lock stitch. These have different characteristics which are best illustrated by using the Goodyear welted construction previously referred to.

CHAIN STITCH / INSEAM WELT SEWING

The machine awl carries a single thread through the layers of material to be sewn where it is caught by a hook and then pulled back, leaving a loop round the hook on the other side. The awl moves forward, cuts through the layers as before and passes through this loop before creating a second loop round the hook and returning. This is repeated to form a continuous seam (Figure 7).

The stitch is used for inseam welt sewing as it is not open to any damage in wear which might cause it to come apart. It is also more suited to the relatively long (8mm) stitches normal for this operation. The thread is passed through a hot wax which 'sets' its characteristics and seals the awl holes to prevent water ingress. This is the all important seam on Goodyear welted footwear and if not done correctly with the right thread, the whole shoe can be ruined.

LOCK STITCH / OUTSOLE STITCHING

The lock stitch is more familiar as it is also used on 95% of all upper stitching operations. A sole stitching machine, however, does not work in quite the same way. Instead of a needle, it has an awl and a hooked needle. The welt of the shoe is held upside-down on a table through which an awl passes upwards to make a hole through the welt and sole.

A hooked needle then passes downwards through this hole, catches the top thread and pulls it back through the hole to form a loop. This is in turn caught by a point on the outer casing of a shuttle containing the bottom thread which, as it revolves, forms the final stitch. This process is repeated at anything up to 600 times per minute depending on the materials and total sole thickness involved.

The critical factor here, as in upper stitching, lies in the top and bottom thread balance and the lock between them (Figure 8). Stitch tension should be set to achieve the correct lock according to the various material thicknesses involved. The ideal position is one-third the way into the sole from the

interface of the welt and sole. This minimises the risk of any shearing action and seam failure if not sufficiently tight. If the lock is positioned at the interface between the sole and welt or close to the outer face of the sole, premature failure can occur quite quickly in wear.

The bottom or shuttle thread is waxed, which helps to create a rigid ‘holding peg’ for the top thread, preventing the detachment of the sole from the welt after the top of the bobbin thread is worn away through wear. It again also helps to improve the water resisting properties of the shoe.

THREAD BALANCE

For good sew-ability and performance in wear, it is always best to match top and bobbin threads in terms of size, fibre type and construction. This may not always be practical or economical but the priority is to ensure compatibility and suitability for the shoe type and its inherent wear expectation. It is common to find when examining returned faulty footwear, failure has occurred at the intersecting loop between top and bobbin threads. This is often the result of mismatched sizes and different substrates, where one thread has cut into the other. A loop strength and thread-to-thread abrasion test will measure this and give a good indication of seam strength and thread type compatibility in the lock.

STITCH DENSITY

The other important aspect of sole stitching is stitch density. Generally, the higher the density, the stronger the sole attachment provided the materials stitched are not over-perforated. The following table (JH Thornton) gives an approximate guide to setting up a sole stitching machine for

various sole edge thicknesses. When in doubt, however, always seek expert advice. Thread suppliers employ experienced technical staff able to advise on all aspects of sole stitching.

Figure 7 – Chain Stitch / Inseam Welt Sewing.

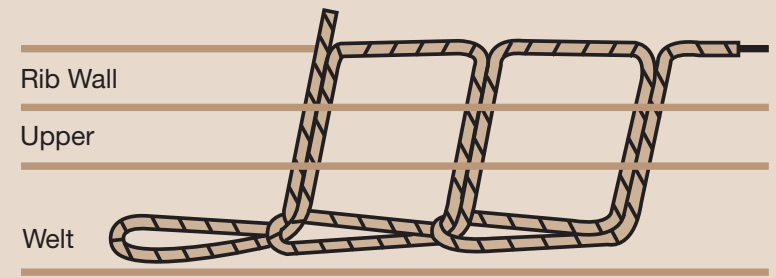
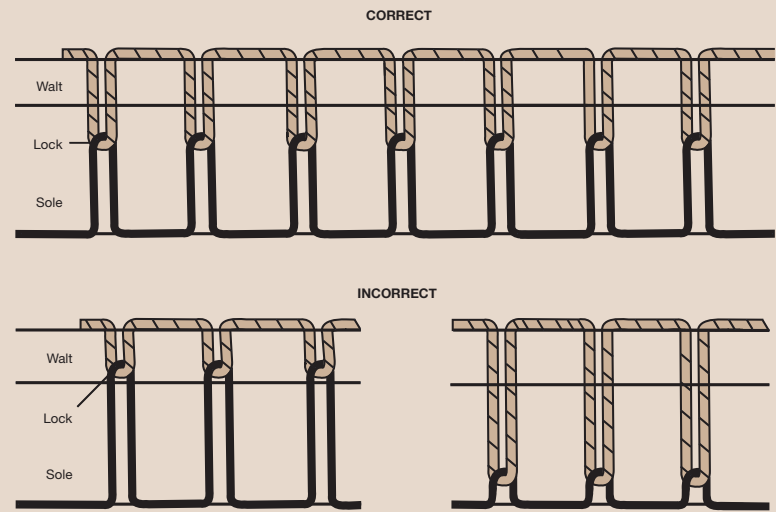


Figure 8 – Lock Stitch / Outsole Stitching.



APPROXIMATE SOLE STITCHING VALUES					
Edge (irons)*	Stitches (per inch)	Needle	Awl	Shuttle thread	Top thread
4 – 5	12 upwards	56	56 or 54	3 cord	4 or 5 cord
6 – 9	11 upwards	54	54 or 52	4 cord	5 cord
9 – 11	9 upwards	52	52 or 50	5 cord	6 or 7 cord
11 – 13	8 upwards	50	50 or 47	5 cord	7 or 8 cord
13 – 15	7 upwards	47	45 or 43	6 cord	8 cord
15 – 20	6 upwards	45	43 or 41	6 cord	8 or 9 cord
	5 upwards	43	41 or 39	7 cord	9 cord
	4 upwards	41	39 or 35	8 cord	9 or 10 cord
	4 upwards	39	35	9 cord	10 to 12 cord

*The term ‘iron’ is the traditional unit of thickness measurement for leather soles and equals 1/48 inch, so a 12 iron sole measures 1/4 inch or 6.4mm.