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*Resistance to bursting is a critical factor with zippers.*

# The function of footwear fasteners

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Current footwear styles use fasteners in two ways: firstly as a means of securing the shoe and, secondly, as fashionable design features. As a means of holding the shoe on the foot, the fastener should be considered a safety-critical component as the loss of a shoe could cause an accident and subsequent injury to the wearer. Aside from accidental injury, fastener failure may automatically make the footwear unwearable. Fasteners therefore need to provide satisfactory performance in use.

## LACES AND LACE CARRIERS

For modern footwear styles, the most popular fastening system remains the

humble shoe lace. However, there are many different types of lace carrier including the traditional eyelet (in many forms), D-rings, ski-hooks and moulded plastic facings. Whether their use depends on fashion or function, the basic requirements remain the same. Neither the lace nor the carrier should fail prematurely. The latter must be securely attached to the upper and the lace should remain knotted once tied.

The main causes of lace breakage are due either to poor strength or poor abrasion resistance, particularly when wet. It is difficult to ascertain the true number of lace failures in wear as many failed items will be replaced by the wearer without the supplier ever

knowing. Supplying a second pair with the shoes will usually demonstrate good customer care, particularly if the colour of the laces is a design feature. However, lace replacement is no doubt annoying to the wearer and future repeat footwear sales may be lost to discerning customers. It is therefore important to ensure that a good quality shoe lace is supplied in the first place.

Laces which readily come undone are also likely to cause customer dissatisfaction, as also is detachment of the tags (the plastic or metal tubes applied to the ends of the lace). This can lead to fraying of the ends which looks unsightly and prevents rethreading of the lace.

Lace abrasion may occur where it rubs against either the carrier or another section of the lace. While this can be due to poor quality, faulty carriers are more common causes as any sharp edges will quickly abrade most textiles used. These faults are not limited to the less common types of carriers such as D-rings and ski-hooks. Eyelets can be just as troublesome if not properly clenched, which can be due to incorrect size as much as poor attachment.

The strength of the carrier and its attachment to the upper needs to be sufficient for the footwear application in which it is used. The lace/carrier assembly should always be tested as a unit in order to determine that even the weakest link performs to the required minimum standard. In addition, the mode of failure gives valuable information on where any improvement in construction may need to be made. A recent fashion trend is the use of clips or toggles to secure the lace rather than conventional tying into a bow. In this instance, the toggles must clamp the lace at least as securely as a bow in order to function correctly.



*Laces should be tested for strength and resistance to abrasion.*



*It is always preferable to test the strength of the complete buckle and strap assembly.*

## ELASTICS

Elastics can have many functions in a shoe upper, ranging from conventional gussets as part of a buckle or strap assembly, through to complete elasticated uppers. Whatever their use, they must be able to stretch sufficiently to allow foot entry while retaining optimum tension to hold the shoe comfortably and securely on the foot.

Conventional elastics consist of fine rubber threads held in an extensible textile matrix. Excessive elongation will cause permanent damage to the textile component, resulting in unsightly wrinkling and loss of performance. However, a common cause of failure of elastics is degradation and rupture of the rubber threads due to fatigue which, if the rubber has a poor resistance to ageing, can occur early in wear. This leads to laddering, wrinkling and loss of tension. Another critical part of elastic component design is how they are attached to the upper. Any stitching must be sufficiently strong yet cause minimal damage to the rubber threads within the elastic.

Special ladder elastics are now commonly used as a means of attaching

buckles to straps. These types of elastic have an open mesh 'ladder' section down the centre which accommodates the buckle prong. In many cases, the extra extension this gives the strap/buckle construction allows the shoe to be donned without undoing the buckle. These ladder elastics may be a vulnerable point, so ensuring they meet minimum strength and extension criteria is essential to satisfactory performance in wear.

## SLIDE FASTENERS (ZIPPERS)

Slide fasteners come in two basic forms, either with separate teeth (plastic or metal) or with continuous plastic spiral chains. Because of their complex construction and their availability in different weights and sizes, it is important to test all aspects of their performance in order to choose the correct slide fastener for the specific end use.

The attachment of all or part of the puller to the slider is often the weakest part of a zipper and the fashion for decorative multi-section pullers increases the risk of failure. It is worth

considering that the loss of the puller could lead to a product return even when it still is possible to open and close the zipper and its functioning is not affected once closed. Attachment of end stops is also important to ensure that the slider is not pulled completely off the teeth.

The security of the actual teeth (their ability to hold the zipper closed against a load across the teeth) is one of the more critical properties to performance in wear and the level of this resistance must match the application. In addition, the design of footwear containing zippers must allow for the extra stresses which could be applied to them in areas of flexing. These areas are best avoided, as are designs which require curvature of the zipper. Both curvature and flexing can lead to premature deterioration of slide fasteners in wear.

## STRAPS AND BUCKLES

Buckles are a familiar feature on many consumer products including footwear. A wide variety of buckles has been developed over the years to cater for this diverse market, but the only type

that has been widely adopted within the footwear industry is the pronged form. Although most buckles used in footwear are made of metal, some injection-moulded plastics are employed, particularly where the colour or design of the buckle are important factors in footwear styling.

Pronged-buckle fastening systems usually provide a satisfactory means of securing the shoe on the foot, which is the key advantage they hold over other forms of buckle. Although they can be tested as independent units, it is always preferable to measure the strength of the complete buckle, strap and upper attachment assembly. As with lace/facing tests, this determines the weakest link and indicates where improvements may be required in materials or construction.

## TOUCH-AND-CLOSE FASTENERS

Touch-and-close fasteners have been a popular choice of fastening for several years and are used in a wide range of applications including footwear, bags and clothing. The type generally used in footwear consists of two components, a tape with flexible crochet-type hooks and a tape with a soft velour-type fabric containing multiple loose loops. As the tapes are touched together, the hooks and loops become firmly intermeshed, hence they are also frequently called hook-and-loop fasteners.

Whatever the application, touch-and-close fasteners must provide a secure fastening which will not deteriorate below a critical level during the lifetime of the shoe. When footwear is being worn, the fastener must resist 'peeling' forces (one tape pulling away from the other) and 'shearing' forces (one tape sliding over the other) and remain functional after being closed and opened many times.

The closure strength of touch-and-close fasteners is closely linked to properties such as the density of the loops and hooks, their ability to interlock and to remain interlocked when under stress. However, peel strength in the final product will also depend on the width of the overlap of the tapes, while shear strength is dependent on the area of overlap. In other words, the strength is dependent not just on the inherent properties of

the tapes themselves but also on the way the shoemaker uses the fastener. A simple rule of thumb is the narrower the strap, the greater the risk of problems.

Some straps, however, are not the simple overlap type as they incorporate a loop-back construction where the strap passes through a slot and is then folded back on itself. Although this results in higher shear strength of the complete strap, the risk of peeling detachment remains the same as for a simple overlap construction. Therefore, it may be possible to achieve satisfactory shear strength using a smaller contact area on a loop-back strap than on a simple overlap strap.

## PRESS STUDS

Press studs, also known as snap closures, are commonly used on clothing and leather goods. They cannot normally offer the same level of adjustment as straps and buckles or touch-and-close fasteners.

Although high attachment strengths are achievable with some larger press studs, most will not be able to achieve

sufficient strength levels for footwear and many are known to deteriorate in strength after a relatively few opening and closing cycles. In most cases they should not be used as a primary fastening system but can be used as a complementary fastener in conjunction with zippers, elastics or other components.

## MAINTENANCE OF APPEARANCE

Fasteners are not only expected to function well during the lifetime of the footwear, but they should also maintain their appearance. This is especially important where the fastener has a high fashion element. Components that are painted or lacquered can suffer abrasion damage, while those with metal components carry a risk of tarnishing or corrosion.

Tarnishing is a surface effect, normally black or dark staining on shiny metals that can spoil the appearance of the footwear. It usually has no adverse effect on the performance of the fastener. Corrosion (rusting), in contrast, not only



*Press studs are best used as a complementary fastener only.*

adversely affects appearance but will also degrade the metal and lead to failure of the component itself or of associated materials (for example a lace where the carrier is metal). Any component at risk of deterioration should be assessed prior to shoemaking to establish the risk of such problems occurring under the expected wear conditions.

### FASTENERS: SAFETY-CRITICAL

All fasteners must be safe in use. They must be securely attached and have no sharp edges or points that could cause cuts or other injuries. As mentioned, if the failure of a fastening leads directly or indirectly to the footwear coming loose or even being lost from the foot, then any resulting trips or slips may cause injury to the wearer. Fastening systems must therefore be considered safety-critical aspects of construction and given the attention they deserve.

The presence of toxic chemicals or allergens must also be considered in

this respect. The most widely encountered allergen in fasteners is nickel and a significant minority of wearers (particularly women) are likely to be affected by the presence of this metal, even at low concentrations in a component. Nickel is most commonly used as a plating on fasteners such as buckles, eyelets and zippers.

In many countries around the world, the presence of toxic chemicals and allergens in consumer products is controlled by law. Suppliers of footwear need to be aware of the local regulations within their target markets to ensure compliance. Product recalls due to breach of such safety regulations can be expensive in terms of both money and loss of reputation.

A further issue to take into account is whether the fasteners present a risk of becoming interlocked or entangled with the other shoe, causing the wearer to trip and fall. Problems of this sort have led to safety recalls in Europe and the US—for example zipper pullers that have interlocked in wear. A proper risk assessment at the product

development stage should ensure that this sort of problem is avoided.

Footwear for young children brings its own particular additional requirements. These are primarily related to the fact that if an object can be sucked, bitten or just placed in the mouth, young children are likely to do so. With this in mind, it is vital to ensure that fasteners on footwear for young children do not present a choking hazard (one of the most common causes of footwear safety recalls) and are also free from ingestible toxic materials. Fastener-related examples of choking hazards include zipper pullers that become loose, buckles that break under low loads and press studs that detach easily.

Choosing a fastener may seem a straightforward task, but there are many issues to take into account. The right choice of fastener can make an enormous difference to the appeal of a particular footwear style. The wrong choice can bring wear returns and safety recalls. 

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