The use of cork filler

Cork is a popular and sustainable material with various footwear applications. ROSIE MOLCHER explains where the material comes from and how it is used.

A natural material, cork is obtained from the bark of the cork oak tree, *Quercus suber*. Cork trees are native to the Iberian Peninsula, and are cultivated commercially in the Mediterranean regions of Europe and Northern Africa. Portugal is the main exporter of cork, producing approximately 50 per cent of the global supply.

Cork trees are slow growing and live for a long time – some being as old as 250 years. The bark can first be harvested when the tree is approximately 25 years old, and then every 9-12 years thereafter. The bark is peeled away from the tree by hand, leaving a thin layer of cork as protection. This allows the bark to grow once again, making cork a renewable resource. Cork cultivation is considered a sustainable and environmentally-friendly industry. It is ecologically important, with cork forests helping to prevent desertification and provide a habitat for endangered species of wildlife (such as the Iberian lynx and imperial eagle). The acorns of the cork tree are also an important food resource for wildlife and livestock. Due to the economic and social importance of cork oak forests, they are protected in the EU under the Habitats Directive 92/43/EEC.

The bark of the cork tree has been harvested for thousands of years as a valuable commodity. Its use can be dated back to Roman times, when it was used for buoys for fishing nets and for sandals. Over the centuries, cork has also been used as an insulation material for buildings. Today, cork is most commonly used for wine bottle stoppers, as well as in notice boards. In the footwear industry, it is used for wedge sole units, insocks, and as a bottom filler – predominantly for welted footwear.

Cork bark being harvested in Portugal

The Goodyear welted construction

In traditional Goodyear welted footwear, a ribbed insole is used, to which the upper is stitched. A welt is then sewn to the upper and rib, which is later used to attach the outsole and complete the construction. The rib forms a void between the insole and outsole, which needs to be filled. A variety of materials may be used as a filler, including expanded rubber, soft ethylene vinyl acetate (EVA) and felt, although cork has been used for many decades and remains a popular choice. A number of factors will influence the choice of material, including comparative costs and performance characteristics.

For use as a bottom filler, cork can be used in sheet form. However, it is more usually processed into a crumb and then blended with other ingredients to form an adhesive cork paste. The exact formulation will be a proprietary blend, and will vary according to the manufacturer. A solvent such as acetone will be included, and the formulation may also include a plasticiser. In the footwear factory, a machine is typically used to apply the cork paste, which is then spread by hand using a hot knife to completely fill the void formed within the insole rib. This is carried out after the welt has been attached, along with the shank. The cork-filled footwear is then left to dry thoroughly before the manufacturing process continues with the attachment of the sole unit.

In terms of performance characteristics, cork is often considered the preferred option for bottom filler. For moisture management in particular, cork filler products give good results compared to a rubber or other polymeric material. Air pockets that form in the cork filler permit moisture to move more easily than, for instance, a solid piece of rubber cut to fit the cavity.

The natural properties of cork convey several benefits to the finished shoe. The shock absorption properties are beneficial in improving the comfort of the footwear, with the elastic nature of the cork providing cushioning on heel strike. The bottom filler also improves comfort by moulding to the shape of the wearer's foot. Cork filler remains spongy and flexible after drying rather than becoming solid. This allows it to easily conform to the foot, and it can give the effect of a custom fit that also improves the comfort of the footwear.

Spreading cork bottom filler

Soft EVA materials can similarly take on the shape of the foot. When a rubber material is used, it may not mould to the wearer's foot in the same way. However, it may still enhance shock absorption and cushioning, depending on the hardness and elasticity properties of the rubber.

Cork filler also provides a layer of thermal insulation, helping to prevent excess heat loss to the underfoot surface. This property will also be influenced by the other components of the outsole unit, so the overall thermal comfort may vary with different styles and outsole materials.

Practical considerations

A major consideration in the use of cork filler is the drying time. The filler must be completely dry before the sole unit is attached to prevent trapping excess moisture in the construction. Until this moisture eventually dries out through the insole board, it could affect any moisture-sensitive adhesives and compromise the strength of the adhesive bond.

Solvent-based products are often used, which to some extent reduces the potential for moisture to be trapped. A solvent-based blend will dry much faster than a water-based product. Therefore, if a change is made from cork filler with a solvent base to one based on water (or vice versa), it is important that the effect on the drying time is understood before it is used in full production. The drying time will also be influenced by the viscosity of the wet product, which needs to be loose enough to be spread easily, without being so wet that it takes an excessive length of time to dry.

The cork filler will shrink as it dries, so it is also important that the degree of shrinkage for the product is known. Slightly more filler may need to be applied to account for this, to prevent the formation of a cavity within the finished footwear.

Once it has dried, the cork filler should have an appropriate level of flexibility to resist crumbling, splitting or cracking during wear. The water resistance properties will also be important during wear, as moisture from either perspiration or water ingress from outside the footwear could degrade the bonds within the filler and cause it to break down over time.

In the factory, cork filler should be stored in accordance with the manufacturer's recommendations to prevent it becoming too dry before use. Any machinery used to apply the cork filler should be appropriately maintained and kept clear of any debris that may dry and clog the machine. This may not be considered an issue for machinery

Cork filler drying before attachment of the sole units

that is routinely used and therefore kept clean by the regular passage of fresh cork filler, but this possible problem should be kept in mind if the equipment is not used for a period of time.

Use in the factory environment

All footwear manufacturing processes require a consideration of relevant health and safety precautions. In the use of cork filler, these are mostly related to the use of solvents. In the case of cork filler, acetone is often used due to its high work place exposure limit (WEL) compared to some other solvents, as well as its low boiling point and rapid evaporation, which helps with quick drying. Local exhaust ventilation (LEV) and suitable gloves (if necessary to minimise skin contact) should be provided, and appropriate tests should be conducted.

The use of solvents and plasticisers in the adhesive blend also present environmental considerations when it comes to the disposal of any leftover product. Once dried, the excess material should be relatively easy to dispose of in accordance with the manufacturer's recommendations, as well as local regulations.

Assessing performance

There are several test methods relevant to cork filler – to monitor the quality of a filler in use or compare different products to determine the most suitable one for an application.

The flexing resistance of the filler can be tested either in a finished shoe, using SATRA TM92:2016 – 'Resistance of footwear to flexing' or, after application to a ribbed insole, using the Bata belt method described in SATRA TM133:2017 – 'Resistance to crack initiation and growth – belt flex method'. Following testing to a suitable number of flexes (as appropriate for the method being used), the filler can be examined for signs of degradation, such as cracking or crumbling. To determine water resistance properties, the flexing resistance could be assessed as described above following a suitable exposure to moisture, such as SATRA TM376:2009 – 'Advanced moisture management test' or by a simple soaking procedure.

Properties essential to comfort should also be considered. Cushioning of the heel strike is best assessed using SATRA TM159:2018 – 'Cushioning properties', before and after a procedure designed to simulate wear, such as SATRA TM156:2002 – 'Resistance of heel assemblies to repeated compression'. Shock absorption properties can also be assessed separately using SATRA TM142:1992 – 'Falling mass shock absorption test'. The thermal properties of the filler can be measured by moulding discs of the filler for SATRA TM146:1996 – 'Thermal conductivity'.

When choosing a bottom filler, whether cork or an alternative material, the key performance parameters should always be considered. SATRA recommends giving close attention in particular to compression set, as measured by SATRA TM159, and shrinkage as measured by SATRA TM238:2004 – 'Shrinkage of foam materials'.

How can we help?

Please contact SATRA's footwear testing team for further information on the use of cork filler in footwear, or assistance with the testing of shoes or components utilising this material.

footwear@satra.com