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Safety footwear developments

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Well engineered safety footwear offers protection from a variety of dangers in a range of working environments. As awareness of the importance of using safety footwear grows, countries that previously had no standards are now adopting published standards as a means of demonstrating that footwear used within their borders offers the necessary level of protection from hazards such as accidental impacts and crushing. These standards contain comprehensive laboratory testing and

performance requirements. Recently, changes were made to a number of safety footwear standards.

INTERNATIONAL STANDARDS

Currently, there is no single safety footwear standard accepted across the world. Three main series of standards exist which, between them, are accepted by a majority of countries. The EN ISO 20344 series of standards produced by the Comité Européen de Normalisation/International Organisation for Standardisation

(CEN/ISO) are probably the most widely accepted. These harmonised standards are recognised by the European Commission as possessing the presumption of conformity to the Personal Protective Equipment (PPE) 89/686/EEC Directive and are the most commonly used method of demonstrating a product's compliance with this directive.

These standards have either been wholly adopted or used by countries as a basis from which to develop their own standards. Australia and New Zealand are examples of the latter. The

AS/NZS 2210 series are almost entirely based upon EN ISO but with a number of small additions detailed in the ZZ annex to the standard. These additional tests include breaking strength for threads, rot-resistance for threads containing natural fibres and requirements for print legibility of labelling.

Countries adopting EN ISO but, being outside the jurisdiction of the European Commission, may be able to demonstrate that their footwear meets the same standards as those supplied within the EU. They would not however be able to obtain a CE mark which forms a part of the certification process against the PPE Directive. Other countries may have their own certification process, such as Australia's and New Zealand's five tick or 'tick tower' which is awarded by SAI Global on demonstration that a product meets all the necessary standards.

America and Canada have their own standards. The American Society for Testing and Materials (ASTM) and Canadian Standards Association (CSA) have both produced safety footwear standards which, while not quite the same, do share similarities. These standards take a less comprehensive approach than EN ISO which contains assessments of key safety features as well as performance requirements for the complete shoe and its components.

ASTM and CSA standards focus only on key safety features such as requirements for the effectiveness provided by toe caps, penetration-resistant inserts and metatarsal protection. The tests described in the three standards check similar properties although the actual test method, equipment and requirements differ. Hence, it is not possible to make a simple direct comparison between EN ISO and ASTM/CSA standards for the same tests. South and Central America often look to ASTM for influence for their standards and ASTM standards may appear in countries from these regions.

LATEST EN ISO STANDARDS

Recent work by (CEN/ISO) working groups has resulted in the publication of the latest versions of three industrial footwear standards as part of a planned five-yearly review process.

They are:

BS EN ISO 20344:2011

Personal protective equipment (footwear test methods).

BS EN ISO 20345:2011

Personal protective equipment (safety footwear).

BS EN ISO 20345:2012

Personal protective equipment (occupational footwear).

These replace previous versions published in 2004. EN ISO 20344 contains details of relevant test methods for assessing footwear which are either contained within the document or by reference to further published standards. EN ISO 20345 contains performance requirements for safety footwear with a protective cap capable of withstanding impacts of up to 200J (joule) and compressions of up to 15kN (kilo newtons). EN ISO 20347 contains requirements for occupational footwear which does not incorporate a protective toe cap, but does have other protective features.

The latest version of a fourth standard, EN ISO 20346:2004 Personal protective equipment (protective footwear) is in the process of being finalised and is expected to be published in 2014. This contains performance requirements for footwear with a protective toe cap capable of withstanding impacts of up to 100J and compressions up to 10kN.

The standards cover two classes of footwear: Class I (footwear made from leather and other materials) and Class II (all-rubber or all-polymeric footwear). All three contain a core of mandatory tests plus additional optional testing. This allows manufacturers to make further performance claims by using marking categories which demonstrate that products meet the requirements associated with these selected additional properties. Footwear meeting only the mandatory requirements is labelled 'SB' for safety footwear, 'PB' for protective footwear and 'OB' for occupational footwear.

For ease of marking, the most widely used combinations of basic and additional requirements have been put together in group categories. Individual codes also exist and are often used in conjunction with these. For example, footwear labelled as code 'SB P'

indicates the item meets the mandatory requirements and provides penetration resistance in addition. Optional coding also includes anti-static footwear, water resistance and footwear containing ankle protection.

The changes to these standards from the 2004 versions are mainly editorial in nature or provide additional clarification to existing procedures. However, there are a number of changes to test methods and requirements. The most significant concerns non-metallic nail-penetration-resistant inserts, which will be discussed later. The 2011 version also has a higher-level requirement for abrasion resistance for counter linings.

FIREFIGHTERS' FOOTWEAR

A further standard, BS EN 15090:2012 Footwear for firefighters, has also been published and now replaces the previous 2006 version. This test method is applicable to firefighters' footwear and contains performance requirements for flammability-related properties and design requirements. For all other properties, the standard refers to the 2011 version of EN ISO 20345.

The 2006 version contained requirements for three different tests for electrical properties and footwear needed to comply with one of these options—electrically insulating footwear, antistatic footwear and high electrical-resistant outsoles. The 2012 version only contains requirements for electrically insulating footwear and antistatic footwear, those for high electrical resistant outsoles having been removed.

IMPLICATIONS OF THE CHANGES

On 1st July 2013, the presumption of conformity with the Personal Protective Equipment (PPE) 89/686/EEC Directive transferred to the latest versions of these standards. This means that footwear covered by EC Type-examination certificates to the superseded version of EN ISO 20345 can only continue to be placed on the European market if the certificate has been reviewed.

A Notified Body must check, with reference to the new version of the standard, whether or not the footwear can still be considered to comply with the health and safety requirements of the PPE Directive. This may or may not



Impact resistance test on a steel toecap.

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IMPACT AND COMPRESSION RESISTANCE TESTING

All toe cap protection works on the 'defended space' principle, where the cap provides a shell in which the toes are protected from damage. It is a requirement of EN ISO 20345 and 20346 that toe caps also meet the requirements for their dimensions and corrosion resistance contained within EN 12568 Foot and leg protectors (requirements and test methods for toe caps and penetration-resistant inserts).

Although toe caps may be tested alone, it is important that the whole shoe is assessed as the effectiveness of a cap will greatly depend on satisfactory positioning and the degree of support provided by the sole. Protective toe caps require sufficient support and poor soling materials, pattern design and/or shoemaking can greatly reduce the effectiveness of even the strongest cap.

EN ISO, ASTM and CSA standards all contain methods and requirements for impact resistance of footwear incorporating toe cap protection which may be produced from either metallic or non-metallic materials. The principle of these tests is the same, with a toe section test sample of the complete shoe being assessed for its resistance to impact by a falling mass. EN ISO and the ASTM standards contain test methods to assess the compression resistance of footwear containing toe caps against accidental compression damage; the CSA standard does not. In this instance, a section of the shoe comprising the whole toe region is cut away just behind the cap and compressed between two flat horizontal plates until a pre-set load is reached.

SLIP RESISTANCE

Slip resistance is a complex property involving many factors. Well-designed footwear can however help to reduce the risk of slipping accidents and injury. On a clean and dry surface, a tread pattern is not always necessary. A contaminated surface where, for example, lubricants are present calls for an effective tread pattern that will sweep any liquid aside in the same way that the tread pattern on a car tyre acts, to return the sole to almost dry conditions. The elements of good tread pattern design include soft flexible

involve further product testing. Following this review the certificate must either be updated or withdrawn as appropriate.

For holders of the EC Type-examination certificates, only products reviewed against the 2011 standard should be placed on the market after this date. Any products certified to the previous standards, however, can continue to be sold if they are already further down the supply chain at this time and have left the possession of the certificate holder.

AMERICAN AND CANADIAN STANDARDS

The ASTM standards, which have also seen recent new publications in 2011, comprise two parts, again separating the test methods from the performance requirements. These are ASTM F2412-11 Standard test methods for foot protection and F2413-11 Standard specification for performance for protection (safety) toe cap footwear.

The previous 2005 versions included requirements for footwear containing toe caps. There were two levels of protection, referred to as 'Class 50' and 'Class 75' and covering both men's and

women's footwear. Class 75 footwear contained a toe cap intended to withstand impacts of 75ft-lbf (101.7J) and compressive forces of at least 2,500lbf (11.1kN). Class 50 footwear contained a toe cap which was intended to withstand impacts of 50ft-lbf (67.8N) and compressive forces of at least 1,750lbf (7.7kN).

ASTM standards usually refer to all test requirements and properties in imperial units. They also contain slightly different requirements for men's and women's footwear and are based on US size 9D for the former and US size 8B for the latter. These two levels of protection are broadly similar to the safety and protective EN ISO standards referred to earlier. In the 2011 version, the lower Class 50 footwear option is removed and the standard now only covers Class 75 footwear.

Canadian standard CSA Z195:09, contains test methods and performance requirements in a single document. It again contains requirements for two levels of protection for impact resistance. Footwear with protective caps meeting grade 1 should withstand impacts of up to 125J and that meeting grade 2, up to 90J.

constructions which maximise floor contact and smooth flat wearing surfaces and leading edges on the tread in all directions.

Both EN ISO and CSA standards use slip resistance test methods contained within the EN ISO 13287 standard. In this test, the whole shoe is assessed against sections of test surfaces wetted with an appropriate lubricant. The CSA standard also contains a dry test. The test mimics the first contact with the flooring and a speed of movement is chosen to represent the early stages of the interaction between it and the footwear under test. If the friction is high, slip is unlikely to occur, the opposite if friction is low. The footwear may be tested with the sole in flat contact or with the heel angled at 7° to the test surface.

The EN ISO standard contains a choice of test surfaces and lubricants, which allows the use of different coding on the final footwear that passes these tests. The lubricants and surfaces used simulate possible working conditions the footwear is likely to encounter during normal use. The sodium lauryl sulphate used is a mild detergent solution and simulates a freshly cleaned floor with a degree of slippery soap solution remaining on the flooring. Glycerol is used to simulate an oily contaminant.

The CSA standard has provision for test surfaces and slipping agents other than the primary test conditions, with clay quarry tiles and stainless steel surfaces being used under dry and wet conditions in order to meet user demands. Other slipping agents suggested include oils, greases and detergents.

ASTM standards do not include a slip resistance test. However, following the publication of ASTM F2913-11 Test method for measuring the coefficient of friction for evaluation of slip performance of footwear and test surfaces/flooring using a whole shoe tester, slip resistance testing is available to manufacturers. This test is derived from SATRA's TM144 slip resistance tests and differs from the EN ISO requirements in a number of ways, in that, for example, the mode of testing is carried out with forepart contact rather than flat contact.

EN ISO standards contain performance requirements for each test

condition. By contrast, the Canadian standard only requires that the test data be supplied to the end-user of the footwear. This is usually provided on a printed sheet included in the shoe box.

NAIL PENETRATION RESISTANCE

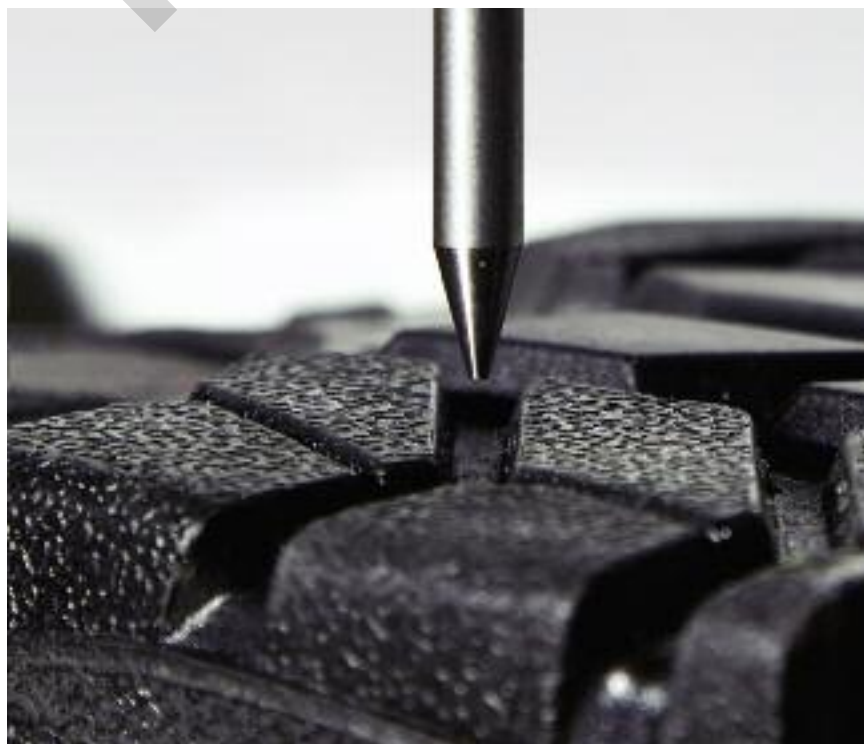
Additional components may be incorporated into footwear to produce nail penetration- or puncture-resistant soles. This is achieved by the inclusion of a metallic or textile insert, usually placed between the outsole and the insole. Metallic inserts have been widely used traditionally but, more recently, tightly woven multiple layered textiles have become more common. Good quality non-metallic inserts can offer a similar level of protection to metallic ones and also allow the use of a wider range of constructions such as Strobel where they are actually stitched in. As they cover the complete bottom of the shoe, there is less risk of any area without protection where an insert might not have been seated correctly or had moved during manufacture. They also have the added benefit of being lighter and more flexible than metallic ones.

The EN ISO standard requires the whole sole unit containing the penetration resistant insert to be assessed for puncture resistance. ASTM

and CSA standards require that the penetration-resistant device be tested prior to insertion into the footwear. Both tests are similar, however, with a truncated steel nail being forced through the sole and insert from the underside through to the foot side, simulating a wearer accidentally standing on a nail. For metallic inserts, the test is stopped once the nail has penetrated and the load needed to cause penetration has been measured.

The 2011 version of EN ISO has a different end-point for the test on non-metallic inserts. In this instance, a load is applied to the nail and the sample visually assessed for penetration. This is different to the 2004 version which was the same as that for metallic inserts. These subtle changes in the testing process have meant that manufacturers using non-metallic inserts in footwear that was assessed to the previous version of the standard have had to re-test in accordance with the new method in order to satisfy the requirements of the PPE Directive.

At the end of the day, the most appropriate series of standards for a manufacturer to test against and be in accordance with will depend on where in the world the footwear is intended to be sold. The range of requirements it needs to meet will depend on the claims being made about it. 📌



Nail penetration test on safety footwear.

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