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Assessing slip resistance

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Slip resistance is one of the mandatory requirements for certified professional footwear. It is also increasingly demanded for other types such as casual footwear as it confers greater added value and comfort. In order to measure slip resistance, different factors have to be taken into account, such as the footwear itself, the flooring and the potential contaminants that might be found. Footwear grip is assessed by measuring the CoF (coefficient of friction) according to the standard EN ISO 13287 under certain combinations of reference floorings and contaminants of which the pass/fail requirements are

already known in order to accept or not the grip values obtained.

INESCOP, the Spanish Footwear Technology Centre, is actively participating in the European Standardisation Committee CEN TC 161 'Foot and leg protection', which is working on the preparation of a testing methodology regarding CoF and the requirements to be applied. This article explains the latest research work contributed by INESCOP to the standardisation committee in helping to define the requirements for new flooring and contaminant combinations that have not previously been considered in existing standards.

MAIN CAUSE OF ACCIDENTS

According to two articles published by *Health & Safety International*, *Mindful Safety* (July 2015) and *Minimising the risk of slips, trips and falls* (February 2019), same level falls are the main cause of accidents at work. These are chiefly attributed to slips (low footwear-flooring grip) and trips (excessive footwear-flooring grip). This entails high costs associated to production losses, as well as social and health expenditure. One of the measures taken to reduce the risk of same level falls is the use of anti-slip floorings and footwear. Despite the great efforts made by many countries, nevertheless a low

success rate has been achieved in reducing the high number of accidents occurring.

The difficulty in solving the problem mainly lies on the great number of factors affecting CoF, the parameter used to assess footwear grip. These, for instance, can involve the normal force to be applied, the speed involved, the possible contaminants present on the flooring, the topography and surface roughness of it, the sole tread design, the soling materials themselves or the sole area in contact with the ground. In spite of the fact that there is a wide range of test methods available and new methods are being developed, not enough consensus has been reached to validate such methods. As a result, there is only one internationally harmonised standard for the footwear sector to assess this property (EN ISO 13287), which only category 2 and 3 certified professional footwear must comply with.

National and international standardisation committees are drafting standards defining the testing methodology and requirements to be applied to each type of product. The European Committee CEN TC 161 'Foot and leg protection' and the Spanish Committee AEN/CTN 81 'Prevention and personal and collective protection equipment' are performing this task for professional footwear. One of the most active groups within the European Committee is Working Group 3, which is in charge of developing the methodology and requirements to assess footwear slip resistance. This is one of the most—if not the most—complex tests among those established by CEN TC 161 over the years.

When this test was developed, it was indeed very difficult from the outset to unify in just one method all the different procedures that had been implemented by European laboratories. The basic principles of those procedures were totally different in some cases, as, for example, the ramp method, where a person wearing the footwear under assessment walks up a ramp and the CoF is measured based on the ramp inclination angle where slip is noticed. Alternatively, there are other procedures that do not involve people but specific laboratory equipment that measures the CoF using artificial feet or lasts fitted with the footwear under study.



The different flooring-contaminant combinations currently considered for certification of professional footwear: left – steel with glycerine and right – Eurotile with detergent.

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ACHIEVING A UNIFIED TEST METHOD

After so many efforts and a series of European inter-laboratory tests involving members of the committee, a unified method was finally achieved, which is currently published in the form of the standard EN ISO 13287. In this method, a last or an artificial foot is fitted with the shoe. It is then placed on a testing surface (flooring) onto which a contaminant is spread. A normal force or vertical force (V) is exerted on the shoe and, finally, it is slid horizontally on the flooring at a constant speed and for a given time. The frictional force (or horizontal force) is measured and the dynamic CoF of the shoe calculated as the quotient of the horizontal force and the normal force. This parameter makes it possible to identify the sole or the shoe with the greatest grip (high CoF values) or with the lowest grip (very low CoF values).

However, the slipping phenomenon is very complex and depends on many variables. At the beginning of footwear slip resistance assessment for certification purposes, there was only one test variation: footwear was flat slid in a forward direction on a standard steel surface contaminated with glycerine. It is to be noted that this movement was a relative one in that some test apparatus moved the shoe while others moved the floor, but

always at the same relative speed, whichever was the case.

Currently, the standard EN ISO 20344 concerning test methods for professional footwear refers to the standard EN ISO 13287 for slip resistance testing where footwear is tested both in flat slip mode and in heel slip mode at a 7° angle, either on a steel surface contaminated with glycerine or a ceramic 'Eurotile' contaminated with detergent. Depending on the test conditions used on the footwear, it is marked as SRA (ceramic tile with detergent), SRB (steel with glycerine) or SRC (both conditions). It is mandatory that one of these three conditions must be complied with for it to be certified. This is indispensable for the free trading and movement of such footwear within the EU.

NEW TEST CONDITIONS

We are currently going through times of change as far as PPE's slip resistance assessment is concerned. For some years, CEN TC 161 has been working on the revision of EN ISO 13287 (slip resistance test method), EN ISO 20344 (professional footwear test methods) and the series EN ISO 20345, 20346 and 20347 (applicable requirements for safety, protective and occupational footwear, respectively). Such revisions are incorporating new test conditions that imply different ways of sliding the

footwear sample on the flooring including the way of mounting the sample, type of flooring and type of contaminant that are more representative of the situations where slipping accidents occur.

These revisions propose that Eurotile contaminated with detergent continues to be mandatorily complied with once they are published but to start using Eurotile contaminated with glycerine (to be optionally complied with) and continue with steel contaminated with glycerine, which will be optionally complied with only within two years after the publication of these revisions. It is also proposed to replace the flat slip mode, with the forepart slip mode, so the latter together with the heel slip mode will be the ones to prevail two years after the publication of the revisions. *(It should be noted that slips mainly occur at the initial or terminal phases of the gait and not during the flat support phase.)*

Laying down these new testing conditions also implies establishing minimum CoF requirements that allow one to discern whether the test has been passed or failed, and whether the footwear can be certified or not. For this reason, several inter-laboratory tests have been conducted within Working Group 3 of CEN TC/161 in order to set the requirements for the new testing conditions. Apart from this work led by the committee, at the last meeting held in Helsinki in May this year, INESCOP presented the results of its own research work that has helped finalise the definition of such requirements.

This research focused on the assessment of the CoF of thirteen sole tread designs including variations in



A number of different sole tread designs were used in the research.

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geometry, cleat height and roughness, and made from seven materials of different polymeric nature from among those commonly used for the manufacture of footwear soles: nitrile rubber (NBR), thermoplastic polyurethane (TPU), polyvinyl chloride (PVC), cellular polyurethane (PUR), compact and cellular styrene-butadiene thermoplastic rubber (SBS) and styrene-ethylene-butadiene-styrene thermoplastic rubber (SEBS). All these combinations, making up a total of 98 different soles, were tested on Eurotile 2 contaminated both with detergent and glycerine in flat slip mode, obtaining the CoF in each case. By way of example, the graph displayed in Figure 1 shows the CoF values obtained for one of the seven materials under study in different sole tread designs.

CONCLUSIONS

It can be concluded that there is a reasonably constant proportion of CoF in ceramic tile with detergent when compared to ceramic tile with glycerine, considering the variety of sole tread designs and materials tested. This

information was taken into consideration for setting the new requirements for testing with glycerine based on the existing requirements for testing with detergent. The new test conditions and requirements will be applicable as of the date of publication of the new standards, which will presumably be by the end of 2019 or the beginning of 2020.

Slip resistance is a property that can be attributed to category 2 and 3 PPE footwear, as this type of footwear is the only one able to provide protection against risks of accident. INESCOP, together with TEMPE and within the European Standardisation Committee CEN TC 309 'Footwear', it is leading the work to define a new specific methodology to measure the grip of footwear types other than professional footwear, as for example town footwear.

This has been motivated by the fact that grip is a property that is increasingly demanded by the market to the extent that it is even required by some customs authorities to accept the sale and use of the product in certain markets. The specific features of this type of footwear which may include high heels, small top-pieces, etc., none of which are present in professional footwear, brought to light the need to develop specific methodology to measure the CoF based on the existing EN ISO 13287. In any case, it is to be noted that non-PPE footwear does not ensure protection against slipping falls but can improve grip to provide greater stability and comfort during the gait cycle. 🌀

**INESCOP is accredited by ENAC (Spanish National Accreditation Body) for professional footwear testing.*

