# COMPARATIVE ANALYSIS OF SLIP RESISTANCE REQUIREMENTS IN TRAFFICKED PUBLIC PREMISES

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# 1. INTRODUCTION

Slip resistance is one of the characteristics deriving from the essential requirements included in Mandate M/119 for floorings according to the construction products Directive (89/106/EEC). After the publication of standard EN 14411, which included the requirements deriving from the application of the CE Mark in Annex ZA, the evaluation of these characteristics has been subordinated to the existence of national regulations in the EU Member States, which can, in turn, define different test methods to evaluate this.

Although Spain has no regulations yet on this point, the Technical Building Code is currently being drafted, whose Basic Document, SU, Safety of Use will include requirements on the slipperiness of floors in buildings and health, education, commercial and trafficked public areas. The assignment criteria of the slip resistance requirements for different service conditions of the areas involved are specified in Table 1.2 of the second draft Basic Document SU-1, which establishes a minimum value of  $R_d > 20$  for use in dry internal areas of public premises.

Based on a preliminary study, it has been verified that a large percentage of Spanish ceramic tile production could not be used in trafficked public premises if these requirements were applied, since they did not reach an  $R_d$  slip resistance value exceeding 20.

### 2. EXPERIMENTAL

With a view to defining the minimum value of friction required to assure user safety on dry internal flooring, it was decided to establish a comparative assessment with regard to the values established in the BGR 181:2003 document (that replaces ZH 1/571), which sets out the requirements for a list of types of industrial and work premises; these include general areas, health, education and commercial premises. For floorings in premises where no presence of fluids related to the relevant labour activity is foreseen, an R9 value is set as minimum requirement. These types of premises are analogous to the 'dry internal floors' category defined in Table 1.2 of Basic Document SU-1. Therefore, in a first approach, a certain equivalence could be considered to exist between class R9 and the minimum value of  $R_d$  that would have to be assigned to these types of premises.

To determine slip resistance value  $R_d$ , the SU Basic Document establishes the use of the test method described in standard UNE ENV 12633:2003 'Method for the determination of the slip resistance value of polished and unpolished floorings'. This method consists of determining the friction coefficient on the surface with saturated water, using a pendulum equivalent to the one described in draft standards ISO/DIS 10545-17 and prEN 13552, applicable to ceramic tiles, but using a rubber of lower hardness (IRHD 59±4) as a slider.

The assignment of class R9 ( $6^{\circ} \le \alpha_{tot} \le 10^{\circ}$ ) is established on the basis of the value obtained of the critical slip angle according to standard DIN 51130:2004 'Testing of floor coverings. Determination of the anti-slip properties; workrooms and fields of activities with raised slip danger, walking method – ramp test'. The method consists of determining the maximum slope that does not generate insecurity in qualified technicians wearing standard safety boots when walking on flooring impregnated with SAE 10 W-30 oil.

In order to define the minimum requirable  $R_d$  value, comparative tests have been conducted with both methods on a wide range of ceramic floor tiles that obtain critical slip angle values below 10°.

# 3. **RESULTS**

As Figure 1 shows, there is no clear correlation between the values obtained with both test methods, probably because the tests conducted simulate quite different service conditions (intermediate fluid and type of rubber).

In the group of ceramic tiles that would receive the R9 classification, the values obtained by the friction pendulum with water as an intermediate fluid range from 11 to 38 units. However, it can be observed that other floor tiles with  $R_d$  values exceeding 11 units do not reach the minimum value of 6 corresponding to this classification.



Figure 1. Comparison of UNE-ENV 12633 and DIN 51130

The most likely reason for this lack of equivalence is related to the absence of phenomena of contact adhesion, owing to the use of oil as intermediate fluid. Under these conditions the resulting friction only depends on the geometric interaction between the surface relief and the sole of the safety footwear. Therefore, this test fails to detect the surface texture of the floor tile.

In contrast, when tests were performed with the pendulum and water as intermediate fluid, all the anchoring mechanisms, stemming from phenomena of contact adhesion and retention by deformation of the rubber, were effective. For this reason, the test is capable of differentiating between surfaces without surface texture and materials with small surface relief, which would be equivalent to the angle value obtained according to DIN 51130, even though they display quite different levels of wet friction.

#### 4. CONCLUSIONS

It has been verified that correlations cannot be adequately established between methods that use different test conditions, mainly in regard to the type of intermediate fluid, since the friction mechanisms vary significantly in these situations.

Ergonomic studies establish, as a reference, a minimum friction of coefficient requirement of 0.1-0.2 (roughly equivalent to an  $R_d$  between 10 and 20) to assure absence of fall risk. Although a scientific criterion for defining a lower bound is unavailable, if the ergonomic criteria, the results of the comparative study with the R9 class (minimum value 11) and the fact that the proposed method simulates the most unfavourable conditions on a floor impregnated with water are taken into account, it may be concluded that the criteria currently envisaged in the 2nd Draft of the SU document are excessively strict for dry internal premises.

Based on these results and on a more extensive study conducted by the Instituto de Tecnología Cerámica (ITC), the Spanish Ceramic Tile Manufacturers' Association (ASCER) has requested that the relevant Authority modify Table 1.2 of the 2nd Draft of Basic Document SU-1, and establish a minimum value of  $R_d$ =15 as the requirement to assure user safety in dry internal premises.