Preventing slips in the food and drink industries - technical update on floor specifications

Food Sheet No 22

Introduction

This information sheet updates HSE booklet *Slips and trips - guidance for the food processing industry* HSG156[1] by giving additional technical factors in specifying flooring. The information sheet covers areas where research has given new or different information with respect to:

1 the measurements that can now be used for measuring slip resistance;

2 confirmation that measuring the coefficient of friction using manually dragged or self-propelled sleds can give misleading results;

3 the importance of considering the viscosity of expected contamination before floor specification;

4 the importance of roughness peak height (Rpm) over peak-to-valley height (Rtm);

5 roughness valley depth (Rvm) being not as important as previously thought for drainage;

6 floor 'hardness' being a factor in slip resistance.

Because slips risks are so much higher in the food and drink industries, principally because of wet or greasy floors, managers in these industries have a particular need to consider the specification of flooring surfaces. The information contained in this information sheet will add to that in the relevant parts of HSG156.[1]

1 **Assessing a floor's potential slip resistance** (expands *Notes* on page 15 of HSG156)

Two important factors which need to be included in any slip resistance assessment are:

- coefficient of friction (CoF); and
- surface roughness (pages 13-16 of HSG156).

HSG156 recommends that previous practical experience of similar floors in real situations may be used as the basis of floor selection. Research has now highlighted a suite of measurements which are also helpful if used correctly within a risk assessment framework.

While avoidance of wet contamination is the first approach, there may be occasions when wet or greasy floors cannot be avoided, and reliance on adequate slip resistance of a wet floor becomes more important. In such cases allowances must be made for the reduction in CoF which accompanies such contamination. The floor's potential slip- resistance in such conditions may now be assessed by an established suite of measurements including floor surface roughness and dynamic coefficient of friction (CoFd), as documented in the *Guidelines recommended by the United Kingdom Slip Resistance Group* [2] (UKSRG).

2 **Measuring coefficient of friction** (expands *Notes* on page 15 of HSG156)

The CoF of a floor surface is, currently erroneously, often the only measure used to indicate that floor's slip resistance. Although CoFd is intimately linked to surface roughness, and is often closely related to floor surface slip resistance, it is traditionally a difficult parameter to measure.

Many measurement techniques exist but some (such as manually-dragged or self-propelled sled-type instruments) may give misleading results, especially when used under wet-contaminated conditions. The preferred technique to measure CoF is the 'pendulum' slip resistance tester as used by the Health and Safety Laboratory in Sheffield. The 'pendulum' tester gives reliable results in wet, oily or greasy conditions - conditions under which most reported slips accidents occur.

Using this technique on a dry or wet surface, values of 36 or more (equivalent to a CoF of 0.36) are currently accepted to indicate satisfactory slip resistance. Further tests are usually carried out after contamination of the test surface with any 'expected' contaminant; this allows an insight into the actual CoF experienced in everyday working situations. Further details may be found in the UKSRG Guidelines.[2]

3 **Importance of contaminant viscosity:** (expands on information given in Table 6 of HSG156)

The presence of wet contaminants between a shoe sole and a floor surface often results in the formation of a squeeze-film (a film of heavily compressed fluid trapped between shoe and floor which prevents 'solid-to-solid' contact). In conditions where physical contact is prevented by squeeze-film formation, CoF is drastically reduced and the risk of slipping is greatly increased. In areas where the type of shoe soling materials in use may not be controlled, the surface roughness of the flooring material must be sufficient to penetrate squeeze-films formed in order to achieve solid-to-solid contact. The level of roughness required to do this is governed by the viscosity of the liquid contaminant present.

HSE research has identified the levels of Rtm roughness which are required to penetrate squeeze-films of differing viscosities sufficiently enough to allow 'satisfactory' CoF values (as assessed using the UKSRG guidelines). These suggested minimum roughness requirements are shown in Table 1. The Rtm values will be helpful in assessing floor specification requirements.

Table 1 Minimum levels of Rtm roughness required to allow satisfactory CoF values

Contaminant Viscosity (cPs)	Workplace Analogue	Minimum Rtm Floor Roughness
< 1	Clean Water	20 µm
1-5	Milk	45 µm
5-30	Stock	60 µm
30-50	Olive Oil	70 µm
> 50	Margarine	> 70 µm

4 The importance of roughness peak height (Rpm) (new information not included in HSG156 pages 15 and 16)

The use of the Rtm roughness parameter is, however, the subject of potential criticism, as values are a measure of *total* surface roughness (peak-to-valley height), a parameter which some consider to contain more information than strictly required.

Recent HSE research has shown that the height of the roughness peak (Rp - see Figure 1) present on a floor surface is responsible for the bulk of its frictional properties (and therefore for its slip resistance) in wet conditions. Research has identified Rpm (the mean of several separate maximum peak height measurements) as a suitable measure of peak roughness. However, it has been shown that the measurement of Rpm is significantly more difficult than that of Rtm. The Rtm parameter is therefore measured far more often in the field.

The correlation found between Rpm roughness measurements and human-based floor surface CoF tests has been shown to be very high, and exceeds that shown by Rtm roughness.

Conclusions have been drawn as to why the measurement of Rpm should correlate so well with human-based CoF test results. Under wet-contaminated conditions, where the formation of squeeze-films may be reasonably expected, research has shown that roughness peaks (the roughness feature directly represented by Rpm) can 'break through' the squeeze-films formed, thus allowing solid-to-solid contact, so increasing CoF and improving slip resistance; the higher the roughness peaks, the greater the film penetration achieved.

Although the correlation between Rpm roughness and human-based CoF test results is strong, it has been identified that different relationships between CoF and Rpm exist for floor materials of different hardness; harder floors generally require greater peak roughness to allow satisfactory slip resistance. Laboratory measurements have suggested that, to enhance slip-resistance in water-wet conditions, soft and hard floor materials should have Rpm values of no less than 8 µm and no less than 25 µm respectively.

Rpm roughness measurements *may*, therefore, be used to estimate the potential slip-resistance of a floor surface before installation, but floor surface hardness must also be considered before a flooring material is specified in this way.

5 Roughness valley depth (Rvm) not as important as previously thought for drainage (new information supplementing HSG156 page 16)

Measurement of the roughness valley depth via the Rvm parameter (the mean of several separate maximum valley depth measurements (Rv), see Figure 1) has been shown not to be of great relevance to floor surface slip resistance.

It is often thought that the presence of 'valleys' in floor surface profiles may allow 'drainage' of wet contaminants, and so improve slip resistance in wet-contaminated conditions. This has been shown not to be the case. Although very small amounts of contaminant may be 'stored' in profile valleys before and during heel strike, contamination cannot easily be 'compressed' into valleys. Valley roughness does not, therefore, contribute to the breakthrough of contaminant squeeze-films, and is therefore of little assistance to slip resistance under 'squeeze-film' conditions.

6 **Effect of floor hardness** (new information not included in HSG156 pages 15 and 16 on selection of flooring)

The most commonly used and accepted measure of surface roughness is Rtm - the mean of several peak-to-valley height measurements (Rt - see Figure 1). This measure is simple, quick, and a good indicator of floor slip resistance.

It has recently been shown that floor surface Rtm roughness levels of at least 20 µm (eg 30 µm) are required to enhance the slip-resistance of hard floor materials (eg ceramics, concrete) in water-wet conditions. This figure may be reduced slightly when considering soft flooring materials (eg vinyl, linoleum).

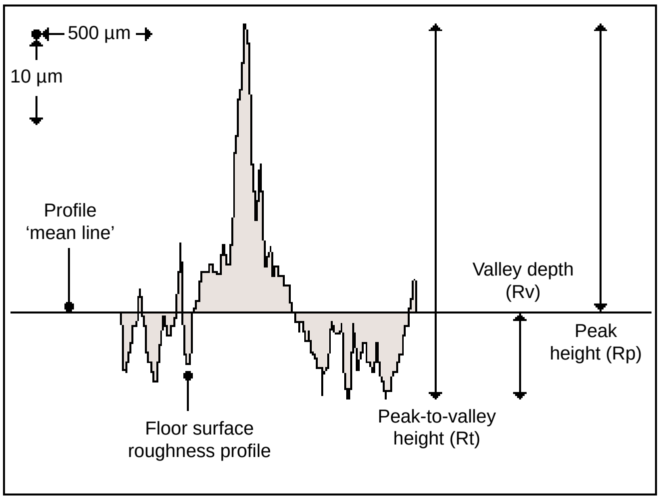

Figure 1 Floor surface roughness profile

References and further reading

1 *Slips and trips - Guidance for the food processing industry* HSG156 HSE Books ISBN 0 7176 0832 8

Slips and trips: Summary guidance for the food industry HSE Food Sheet 6 HSE Books

2 *The Measurement of Floor Slip Resistance: Guidelines Recommended by the UK Slip Resistance Group* 1996 RAPRA Technology Ltd., Shawbury, Shropshire SY4 4NR

HSE priced and free publications are available by mail order from HSE Books, PO Box 1999, Sudbury, Suffolk CO10 6FS Tel: 01787 881165 Fax: 01787 313995.

HSE priced publications are also available from good booksellers.

For other enquiries ring HSE's InfoLine Tel: 0541 545500, or write to HSE's Information Centre, Broad Lane, Sheffield S3 7HQ.

This guidance is issued by the Health and Safety Executive. Following the guidance is not compulsory and you are free to take other action. But if you do follow the guidance you will normally be doing enough to comply with the law. Health and safety inspectors seek to secure compliance with the law and may refer to this guidance as illustrating good practice.

Printed and published by the Health and Safety Executive 5/99 FIS22 C200