HSE

Health and Safety Executive

A study of the slip characteristics of natural and manmade stone flooring materials

Prepared by the **Health and Safety Laboratory**
for the Health and Safety Executive 2007

RR529
Research Report

HSE
Health and Safety Executive

A study of the slip characteristics of natural and manmade stone flooring materials

Dr Marianne Loo-Morrey
Health and Safety Laboratory
Harpur Hill
Buxton
Derbyshire
SK17 9JN

The aim of the current study was to assess the slip resistance of a wide range of natural and man stone flooring. These types of floors are commonly found in a variety of commercial premises where high specification prestige finishes are required, however to date there has not been a systematic study of the slip characteristics of these floors. A better understanding of the anti-slip performance of these flooring materials would better inform the advice given to duty holders considering the installation of this type of flooring. During the initial phase of the work, the ramp boards to be used in the study were characterised using the test methods typically employed during site HSL/HSE investigations:

- surface roughness;
- the pendulum test.

The objective of this phase of the work was to gain a better understanding of natural and man made stone floors and to provide a comparison with the ramp data to be generated in the future. This will help to better inform how ramp data generated in the laboratory setting relates to data obtained from real work places generated by portable test methods.

This report and the work it describes were funded by the Health and Safety Executive (HSE). Its contents, including any opinions and/or conclusions expressed, are those of the author alone and do not necessarily reflect HSE policy.

HSE Books

First published 2007

CONTENTS

EXECUTIVE SUMMARY

The aim of this initial phase of the project was to characterise natural and man made stone ramp boards by means of the portable test methods routinely used by HSL / HSE during forensic site investigations, i.e. Rz surface roughness and pendulum tests.

Rz data collected from the ramp boards resulted in the slip potential in wet conditions presented by the flooring materials being classified as follows:

High Slip Potential:	Polished Marble Agglomerate Polished Granite Terrazzo Natural Finish Terrazzo Gloss Finish Unfilled Travertine Gloss Finish Honed Limestone
Moderate Slip Potential:	Polished Limestone Unfilled Travertine Natural Finish
Low Slip Potential:	Riven Slate Gloss Finish Pebble Mosaic Riven Slate Natural Finish Natural Stone.

Rz surface roughness data indicates that seven of the floors should be classified as presenting a high potential for slip in water-wet conditions, two floors should be expected to present a moderate potential for slip and five floors might reasonable be expected to pose a low potential for slip when wet.

The pendulum test resulted in the slip potential in wet conditions presented by the flooring materials being classified as follows:

High Slip Potential:	Polished Marble Agglomerate Polished Granite Honed Limestone Terrazzo Natural Finish
High / Moderate Slip Potential:	Terrazzo Gloss Finish
Moderate Slip Potential:	Polished Limestone Unfilled Travertine Natural Finish Unfilled Travertine Gloss Finish Artificial Slate Smooth Finish
Low Slip Potential:	Pebble Mosaic Rivan Slate Natural Finish Rivan Slate Gloss Finish Natural Stone

Pendulum data indicates that four of the floors should be classified as presenting a high potential for slip in water-wet conditions, one floor should be classified as having a high to moderate potential for slip in the wet, four floors should be expected to present a moderate potential for slip and four floors might reasonable be expected to pose a low potential for slip when wet.

For the flooring investigated in the current study the agreement in slip potential classifications obtained from surface roughness data and pendulum results was very good:

- For 11 out 14 floors the slip potential classifications based on surface roughness and pendulum data were the same.
- For 2 out of 14 floors the surface roughness data under estimated the slip potential of the flooring materials as determined by the pendulum i.e. the flooring was less slippery than might have been expected from roughness alone.
- In only 1 case did the surface roughness data under estimate the level of slip potential of the floor as determined by the pendulum i.e. the flooring was more slippery than might have been expected.

Overall the findings reported here support HSL / HSE's stance that while Rz is a useful indictor of the slip resistance of flooring materials it is not recommended that it be used as the sole selection criteria on which to base the choice of a new floor. **Wherever possible** surface roughness should be considered in *conjunction with pendulum measurements* in both wet and dry conditions before specification decisions are made.

1 INTRODUCTION

The work detailed in this report was carried out at the request of Mr. Stephen Taylor (Construction Division Technology Unit, HSE).

The aim of the current study was to assess the slip resistance of a wide range of natural and man stone flooring. These types of floors are commonly found in a variety of commercial premises where high specification prestige finishes are required, however to date there has not been a systematic study of the slip characteristics of these floors. A better understanding of the anti-slip performance of these flooring materials would better inform the advice given to duty holders considering the installation of this type of flooring.

During the initial phase of the work, the ramp boards to be used in the study were characterised using the test methods typically employed during site HSL / HSE investigations:

- Surface roughness
- The pendulum test

The objective of this phase of the work was to gain a better understanding of natural and man made stone floors and to provide a comparison with the ramp data to be generated in the future. This will help to better inform how ramp data generated in the laboratory setting relates to data obtained from real work places generated by portable test methods.

2 EXPERIMENTAL

Fourteen floors have been selected for study in the current work (see Table 1). The floors chosen have been selected to be representative of the different types stone flooring available in the marketplace and commonly installed. They range from polished granite to rough natural stone.

Flooring	Type
Polished Granite	Natural Stone
Honed Limestone	Natural Stone
Natural Stone	Natural Stone
Polished Marble	Natural Stone
Pebble Mosaic	Natural Stone
Riven Slate Natural Finish	Natural Stone
Riven Slate Gloss Finish	Natural Stone
Polished Limestone	Natural Stone
Unfilled Travertine Natural Finish	Natural Stone
Unfilled Travertine Gloss Finish	Natural Stone
Terrazzo Gloss Finish	Man Made
Terrazzo Natural Finish	Man Made
Agglomerate	Man Made
Artificial Slate Smooth Finish	Man Made

Table 2.1 Floors used in the current investigation.

Each of the floors was professionally laid onto the ramp boards in accordance with the manufactures instructions and received any recommended additional surface treatments.

The slip resistance of each of the ramp boards used in the current work was assessed using standard test methods as outlined in the United Kingdom Slip Resistance Group (UKSRG) Guidelines using a Pendulum Coefficient of Dynamic Friction (CoF) Test, see Figure 2.2, and a Mitutoyo SJ-201P microroughness transducer, see Figure 2.1. Both test methods are used routinely by HSL during on-site slipperiness assessments and during contract research for HSE. The slip resistance of each floor will be further characterized using the HSL-SOP-12 ramp test during future work.

2.1 SURFACE ROUGHNESS

During the routine slipperiness assessment of a flooring material ten seperate R_z measurements are taken using a standardised three directional methodology to account for surface directional inhomogeneity. Given that the aim of the current work was to characterise the stone floors as completely as possible, the opportunity was taken collect a wider range of surface roughness parameters (R_a, R_z, R_q, R_t, R_p, R_{mr}, R_s) than are typically collected during a site investigation.

Figure 2.1 The Mitutoyo SJ-201P microroughness transducer

2.2 PENDULUM TEST

A Four-S rubber slider was used throughout. Slider preparation was carried out as per the UKSRG Guidelines and BS7976. The pendulum was calibrated by the British Standards Institution; the Surtronic was calibrated against a UKAS roughness standard and checked *in-situ* using a calibrated roughness plate. Interpretations of pendulum data are based on the UKSRG Guidelines, 2005. Interpretations of surface roughness data are based on existing HSE Guidance, Food Information Sheet 22 [HSE] and the UKSRG Guidelines.

Figure 2.2 Slipperiness assessment test methods; the “Stanley” Pendulum CoF test.

3 RESULTS AND DISCUSSION

3.1 SURFACE ROUGHNESS RESULTS

Surface roughness results for the ramp boards used in this work are given in Table 3.1.

Ramp Board	Average Surface Roughness (µm)						
	Ra	Rz	Rq	Rt	Rp	Rmr	Rs
Polished Marble	0.07	0.87	0.12	1.81	0.23	17.9%	52.8(8)
Agglomerate	0.19	2.39	0.32	5.15	0.50	24.8%	46.3
Polished Granite	0.37	3.39	0.64	11.98	0.92	14.1%	43.3(5)
Terrazzo Natural Finish	0.80	4.32	1.01	11.95	1.96	13.1%	81.3(9)
Terrazzo Gloss Finish	0.69	4.79	1.03	12.95	2.87	0.3%	97.5(6)
Unfilled Travertine Gloss Finish	0.81	5.90	1.11	12.5	2.42	1.2%	75.7
Honed Limestone	1.32	8.39	1.72	15.07	2.79	4.7%	59.7
Polished Limestone	1.62	10.43	2.10	16.39	4.30	4.1%	58.8
Unfilled Travertine Natural Finish	1.64	10.90	2.29	23.65	3.44	5.1%	67.0
Riven Slate Gloss Finish	4.43	20.84	538	29.71	10.46	2.4%	194.1(9)
Pebble Mosaic	4.75	21.18	5.82	34.10	10.50	2.3%	83.1
Riven Slate Natural Finish	4.62	22.51	5.60	29.67	10.99	2.1%	117.1
Artificial Slate Smooth Finish	4.62	23.04	5.74	32.59	13.20	1.4%	238.0(7)
Natural Stone	8.50	40.19	10.46	60.31	20.19	2.7%	140.0

Table 3.1 Table giving average values for the surface roughness results for the fourteen ramp boards used in the current study. R_z (μm) values are given in the highlighted column.

Definitions of the roughness parameters presented are given in Appendix 1.

The Rz parameter, highlighted in Table 3.1, is routinely measured during HSL slipperiness assessments and is a useful parameter in predicting the likely slip resistance of a flooring material under water contamination. The (UKSRG) guidelines on the interpretation of surface roughness data is summarised in Table 3.2.

Rz (Rtm) Surface Roughness*	Potential for Slip
Below 10	High
Between 10 and 20	Moderate
Above 20 and above	Low

*Roughness values applicable for water-wet, low activity pedestrian areas.

Table 3.2 Summary table of UKSRG guidelines on the interpretation of surface roughness data.

Comparison of the Rz data for ramp boards used in this study with the information in Table 3.2 results in the floors being classified follows in wet conditions:

High Slip Potential:	Polished Marble Agglomerate Polished Granite Terrazzo Natural Finish Terrazzo Gloss Finish Unfilled Travertine Gloss Finish Honed Limestone
Moderate Slip Potential:	Polished Limestone Unfilled Travertine Natural Finish
Low Slip Potential:	Riven Slate Gloss Finish Pebble Mosaic Riven Slate Natural Finish Natural Stone

Rz surface roughness data indicates that seven of the floors should be classified as presenting a high potential for slip in water-wet conditions, two floors should be expected to present a moderate potential for slip and five floors might reasonable be expected to pose a low potential for slip when wet.

3.2 PENDULUM MEASUREMENT RESULTS

Pendulum results for the ramp boards used in this study are given in Table 3.3. Note, pendulum test results maybe known by a variety of terms, Slip Resistance Value (SRV, which is used in this report), Pendulum Test Value (PTV), and British Pendulum Number (BPN).

Ramp Board	Direction	Dry (SRV)	Wet (SRV)	Slip Potential in wet
Polished Marble	Direction I	99	6	**High**
	Direction II	86	6	**High**
	Direction III	90	6	**High**
Agglomerate	Direction I	72	7	**High**
	Direction II	76	11	**High**
	Direction III	73	9	**High**
Polished Granite	Direction I	113	6	**High**
	Direction II	95	9	**High**
	Direction III	95	11	**High**
Terrazzo Natural Finish	Direction I	89	5	**High**
	Direction II	81	8	**High**
	Direction III	85	6	**High**
Terrazzo Gloss Finish	Direction I	65	24	**High**
	Direction II	67	24	**High**
	Direction III	72	26	**Moderate/High**

Unfilled Travertine Gloss Finish	Direction I	65	28	
	Direction II	67	31	
	Direction III	72	35	
Honed Limestone	Direction I	71	21	
	Direction II	76	22	
	Direction III	66	22	
Polished Limestone	Direction I	71	26	
	Direction II	71	41	
	Direction III	66	25	
Unfilled Travertine Natural Finish	Direction I	66	31	
	Direction II	65	31	
	Direction III	63	31	
Rivan Slate Gloss Finish	Direction I	61	40	
	Direction II	62	43	
	Direction III	61	45	
Pebble Mosaic	Direction I	71	56	
	Direction II	71	64	
	Direction III	70	60	
Rivan Slate Natural Finish	Direction I	64	50	
	Direction II	60	50	
	Direction III	62	52	
Artificial Slate Smooth Finish	Direction I	58	31	
	Direction II	56	29	
	Direction III	56	30	
Natural Stone	Direction I	72	61	
	Direction II	69	66	
	Direction III	70	66	**Low**

Table 3.3. Table giving 4S pendulum results in dry and wet conditions for each of the ramp boards used in the current work.

The (UKSRG) guidelines on the interpretation of pendulum data is summarised in Table 3.4.

Pendulum Value	Potential for Slip
Below 24	High
Between 25 and 35	Moderate
Above 36 and above	Low

Table 3.4 Summary table from UKSRG guidelines on the interpretation of pendulum data.

The pendulum test resulted in the slip potential in wet conditions presented by the flooring materials being classified as follows:

High Slip Potential: Polished Marble
Agglomerate
Polished Granite
Honed Limestone
Terrazzo Natural Finish

High / Moderate Slip Potential: Terrazzo Gloss Finish

Moderate Slip Potential: Polished Limestone
Unfilled Travertine Natural Finish
Unfilled Travertine Gloss Finish
Artificial Slate Smooth Finish

Low Slip Potential: Pebble Mosaic
Rivan Slate Natural Finish
Rivan Slate Gloss Finish
Natural Stone

Pendulum data indicates that four of the floors should be classified as presenting a high potential for slip in water-wet conditions, one floor should be classified as having a high to moderate potential for slip in the wet, four floors should be expected to present a moderate potential for slip and four floors might reasonable be expected to pose a low potential for slip when wet.

3.3 COMPARISON OF SURFACE ROUGHNESS AND PENDULUM RESULTS

The effect of surface micro-roughness on the data generated for the water-wet condition during pendulum testing of the flooring used in the current work is shown graphically in Figure 3.1.

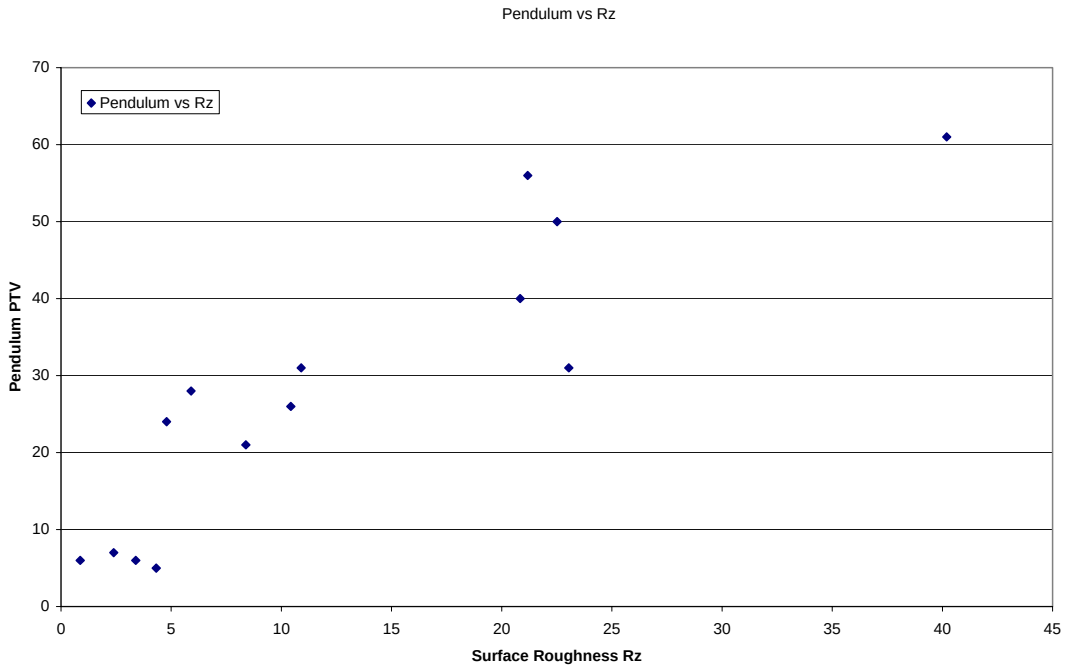


Figure 3.1 Graph showing wet pendulum values plotted against Rz surface roughness.

It can be seen from Figure 3.1 that as a general trend the value water-wet PTV measurements increases as the Rz surface roughness of the natural or man-made stones increases. This is in line with previous work on pedestrian slipping, which has shown that the anti-slip performance of a flooring material is related to the level of surface micro-roughness. Previous studies have shown that for a flooring to exhibit satisfactory levels of anti-slip performance the surface roughness needs to be sufficient to break through the squeeze film formed the floor and a pedestrian's shoe [Richardson and Griffiths, Lemon and Griffiths].

Flooring	Slip Potential in Wet from Surface Roughness Rz (μm)	Slip Potential in Wet from Pendulum Data (SRV)	Agreement
Polished Granite	High	High	Yes
Honed Limestone	High	High	Yes
Natural Stone	Low	Low	Yes
Polished Marble	High	High	Yes
Pebble Mosaic	Low	Low	Yes
Riven Slate Natural Finish	Low	Low	Yes
Riven Slate Gloss Finish	Low	Low	Yes
Polished Limestone	Moderate	Moderate	Yes
Unfilled Travertine Natural Finish	Moderate	Moderate	Yes
Unfilled Travertine Gloss Finish	High	Moderate	No
Terrazzo Gloss Finish	High	High / Moderate	No
Terrazzo Natural Finish	High	High	Yes
Agglomerate	High	High	Yes
Artificial Slate Smooth Finish	Low	Moderate	No

Table 3.4 Summary table comparing the slip potential classifications of the ramp boards obtained using surface roughness and pendulum data generated in the water-wet condition.

In eleven out of fourteen cases (79%) the slip potential classifications of the flooring materials obtained using surface roughness measurements and pendulum data are the same. For the remaining three cases:

Unfilled Travertine Gloss – Surface roughness data indicated this floor is likely to pose a high potential for slip in water-wet conditions. Pendulum data suggests that this floor should be considered a moderate slip risk in the wet. Given the comparatively low level of surface roughness of this material the pendulum results are a little higher than might have been expected. Any specification decision based on surface roughness for this material would result in conservative choice, as the slip resistance of the material in wet conditions appears to be better than could have been predicted from surface roughness alone, i.e choices based on Rz surface roughness alone would fail safe.

Terrazzo Gloss Finish – Surface roughness data indicated this floor is likely to pose a high potential for slip in water-wet conditions. Pendulum data suggests that this floor should be considered a high to moderate slip risk in the wet. Given the low level of surface roughness of this material the pendulum results are a little higher than might have been expected. Any specification decision based on surface roughness for this material would result in conservative choice, as the slip resistance of the material in wet conditions appears to be better than could have been predicted from surface roughness alone, i.e choices based on Rz surface roughness alone would fail safe.

Artificial Slate Smooth Finish – Surface roughness data indicates that this floor is likely to present a low potential for slip in water-wet conditions. Pendulum data however, suggests that this floor should be considered a moderate potential for slip in the wet. Of all the flooring materials investigated in this study this is the only case where selection of flooring on the basis of surface roughness would have resulted in a floor whose slip resistance in the wet that was

worse than might have been expected. A possible explanation for the disagreement in slip potential classifications resulting for surface roughness and pendulum data for this floor may be found in the surface roughness data. The Rs value, the distance between adjacent peaks, is very high for this particular floor. Consideration of the Rz and Rs surface roughness parameters together would therefore imply that although the peaks are capable for breaking through the fluid file formed by water, there are comparatively few peaks to do so. It is therefore not unreasonable for the slip potential of this flooring, as measured using the pendulum method to be higher than surface roughness alone may suggest.

For the flooring investigated in the current study the agreement in slip potential classifications obtained from surface roughness data and pendulum results was very good:

- For 11 out 14 floors the slip potential classifications based on surface roughness and pendulum data were the same.
- For 2 out of 14 floors the surface roughness data under estimated the slip potential of the flooring materials as determined by the pendulum.
- In only 1 case did the surface roughness data under estimate the level of slip resistance determined by the pendulum.

4 CONCLUSION

Surface roughness measurements and pendulum tests were carried out on 14 ramp boards used in the study. Rz data for the ramp boards resulted in the slip potential in wet conditions presented by the flooring materials being classified as follows:

High Slip Potential:	Polished Marble Agglomerate Polished Granite Terrazzo Natural Finish Terrazzo Gloss Finish Unfilled Travertine Gloss Finish Honed Limestone
Moderate Slip Potential:	Polished Limestone Unfilled Travertine Natural Finish
Low Slip Potential:	Riven Slate Gloss Finish Pebble Mosaic Riven Slate Natural Finish Natural Stone.

Rz surface roughness data indicates that seven of the floors should be classified as presenting a high potential for slip in water-wet conditions, two floors should be expected to present a moderate potential for slip and five floors might reasonable be expected to pose a low potential for slip when wet.

The pendulum test resulted in the slip potential in wet conditions presented by the flooring materials being classified as follows:

High Slip Potential:	Polished Marble Agglomerate Polished Granite Honed Limestone Terrazzo Natural Finish
High / Moderate Slip Potential:	Terrazzo Gloss Finish
Moderate Slip Potential:	Polished Limestone Unfilled Travertine Natural Finish Unfilled Travertine Gloss Finish Artificial Slate Smooth Finish
Low Slip Potential:	Pebble Mosaic Rivan Slate Natural Finish Rivan Slate Gloss Finish Natural Stone

Pendulum data indicates that four of the floors should be classified as presenting a high potential for slip in water-wet conditions, one floor should be classified as having a high to moderate potential for slip in the wet, four floors should be expected to present a moderate

potential for slip and four floors might reasonable be expected to pose a low potential for slip when wet.

For the flooring investigated in the current study the agreement in slip potential classifications obtained from surface roughness data and pendulum results was very good:

- For 11 out 14 floors the slip potential classifications based on surface roughness and pendulum data were the same.
- For 2 out of 14 floors the surface roughness data under estimated the slip potential of the flooring materials as determined by the pendulum i.e. the flooring was less slippery than might have been expected from roughness alone.
- In only 1 case did the surface roughness data under estimate the level of slip potential of the floor as determined by the pendulum i.e. the flooring was more slippery than might have been expected.

While Rz surface roughness is a very useful key indicator for the anti-slip performance of flooring materials, some of the data generated for this study suggests that considering a combination of surface roughness parameters such Rz and Rs together may give a more informed indication of the slip potential of a floor. A more detailed analysis of the relationship between surface parameters and slip potential is currently being undertaken for HSE.

Overall the findings reported here support HSL / HSE's stance that while Rz is a useful indictor of the slip resistance of flooring materials it is not recommended that it be used as the sole selection criteria on which to base the choice of a new floor. **Wherever possible** surface roughness should be considered in *conjunction with pendulum measurements* in both wet and dry conditions before specification decisions are made.

5 REFERENCES

HSE, “HSE information sheet, Preventing slips in the food and drink industries – technical update on floor specifications.” Food Sheet No. 22, HSE.

HSE, “The Assessment of Pedestrian Slip Risk – The HSE Approach”, Slips and Trips 1, HSE./

P. Lemon and S. Griffiths, “Further Application of Squeeze Film Theory to Pedestrian Slipping.”, HSL report, IR/L/PE/97/9, 1997.

M. T. Richardson and R. S. Griffiths, “The Application of Squeeze Film Theory to Pedestrian Slipping Research.” HSL report, IR/L/PE/96/4, 1996.

UKSRG, United Kingdom Slip Resistance Group, “The Measurement of Floor Slip Resistance - Guidelines Recommended by the UK Slip Resistance Group”, Issue 3, October 2005.

APPENDIX 1

Definitions of Surface Roughness Parameters.

This Appendix gives definitions (calculation methods) of the roughness parameters investigated in this study.

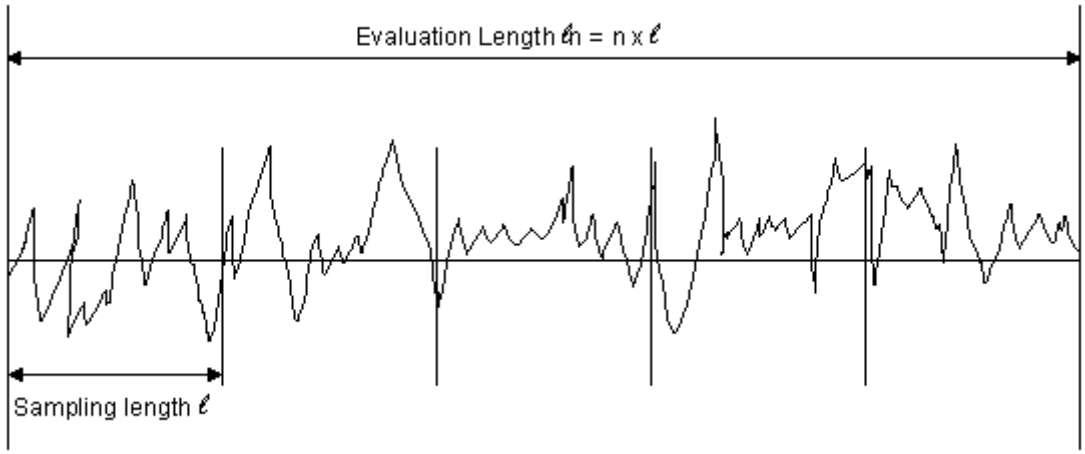


Diagram showing schematic representation of surface roughness trace.

Each of the surface roughness parameters explained in this section is calculates within a sampling length. Specific parameters to be obtained over the evaluation length will be denoted as required.

ARITHMETIC MEAN DEVIATION OF THE PROFILE - R_A

Ra is the arithmetic mean of the absolute values of the profile deviations (Y_i) from the mean line.

$$Ra = \frac{1}{N}\sum_{i=1}^{N}|Y_i|$$

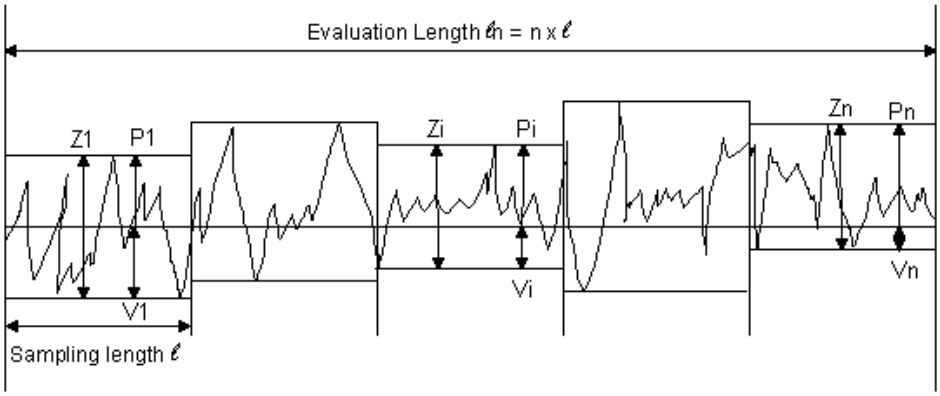
For ANSI, Ra is defined over the entire evaluation length.

ROOT-MEAN-SQUARE DEVIATION OF THE PROFILE, R_Q

Rq is the square root of the arithmetic mean of the squares of the profile deviations (Y_i) from the mean line.

$$Rq = \left(\frac{1}{N}\sum_{i=1}^{N}Y_i^2\right)^{1/2}$$

MAXIMUM HEIGHT OF THE PROFILE, RZ(DIN, ISO, ANSI)



The Rz surface roughness parameter is defined as the mean of the sum of Zi within each sampling length over the entire evaluation length.

$$Rz(DIN) = \frac{Z_1 + Z_2 + Z_3 + Z_4 + Z_5}{5}$$

Where the number of sampling lengths n = 5

MAXIMUM TWO POINT HEIGHT OF THE PROFILE, R_Y(DIN, ANSI)

The maximum value of all the Zi's used to calculate Rz over the evaluation length is defined as R_y (DIN, ISO, ANSI).

MAXIMUM PROFILE PEAK HEIGHT, R_P (DIN, ISO, NEW JIS)

R_p is defined as the mean value of the R_{pi} over the entire evaluation length, where R_{pi} is the profile peak height within each sampling length.

$$R_p = \frac{R_{p1} + R_{p2} + R_{p3} + R_{p4} + R_{p5}}{5}$$

Where the number of sampling lengths n =5.

TOTAL HEIGHT OF THE PROFILE R_T

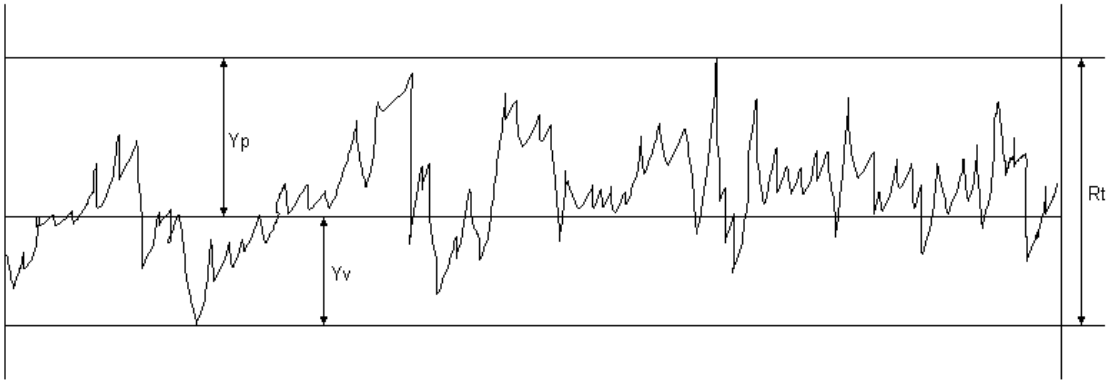
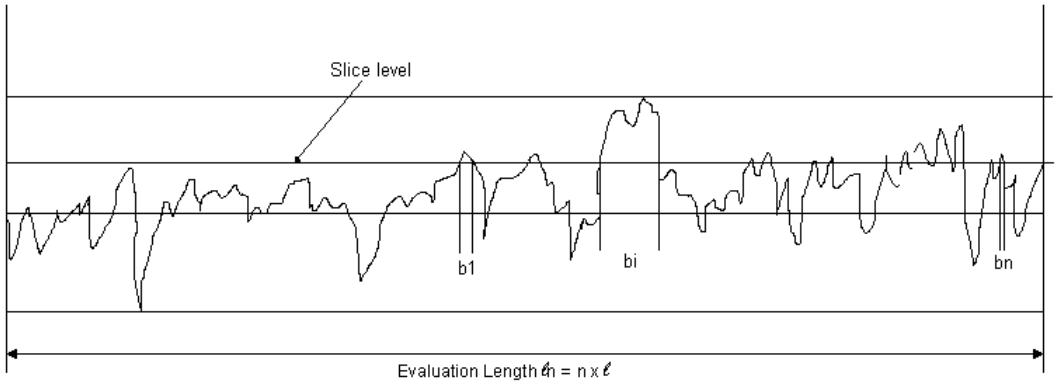


Diagram showing a schematic representation of how Rt is calculated.

R_t is defined as the height of the highest peak and the depth of the deepest valley over the evaluation length.

$$R_t = Y_p + Y_v$$

MATERIAL RATIO OF THE PROFILE, R_{MR}



Schematic diagram showing how R_{mr} is calculated

R_{mr} is defined as the ratio (%) of the material length of the profile elements at a given level (slice Level) to the evaluation length. Here the slice level is defined as the depth from the highest peak, and is called a “peak reference”. The slice level is represented by a ratio of the depth (0 to 100%) to the R_t value.

$$Rmr = \frac{\eta p}{\ln} \times 100(\%) \qquad \eta p = \sum_{i=1}^{n} bi$$

MEAN SPACING OF LOCAL PEAKS OF THE PROFILE, R_S

R_s is the mean spacing of adjacent local. For ANSI, this parameter is defined over the evaluation length.

$$R_s = \frac{1}{n}\sum_{i=1}^{n} S_i$$

Where n = number of peaks.

Published by the Health and Safety Executive 03/07

HSE

Health and Safety Executive

A study of the slip characteristics of natural and manmade stone flooring materials

The aim of the current study was to assess the slip resistance of a wide range of natural and man stone flooring. These types of floors are commonly found in a variety of commercial premises where high specification prestige finishes are required, however to date there has not been a systematic study of the slip characteristics of these floors. A better understanding of the anti-slip performance of these flooring materials would better inform the advice given to duty holders considering the installation of this type of flooring. During the initial phase of the work, the ramp boards to be used in the study were characterised using the test methods typically employed during site HSL/HSE investigations:

- surface roughness;
- the pendulum test.

The objective of this phase of the work was to gain a better understanding of natural and man made stone floors and to provide a comparison with the ramp data to be generated in the future. This will help to better inform how ramp data generated in the laboratory setting relates to data obtained from real work places generated by portable test methods.

This report and the work it describes were funded by the Health and Safety Executive (HSE). Its contents, including any opinions and/or conclusions expressed, are those of the author alone and do not necessarily reflect HSE policy.

RR529

www.hse.gov.uk