GLC BULLETIN 145

ITEM 2 (COMMITTEE DATE 2/85)

Sheet safety surfaces for floors, methods for evaluation

ABSTRACT

This item is concernd with accidents caused to people through slipping on floor surfaces. It discusses the risks of slipping in relation to the activities carried out over the surfaces, together with the health, safety and economic implications. The mechanics of slipping, the factors affecting slipping, and the properties of profiled surfaces are also discussed. The item goes on to describe test equipment and the Council's test programme for the evaluation of floor surfacing products.

INTRODUCTION

Accidents from falls which result from slipping on floor surfaces occur with alarming frequency. Many legal claims have been successfully made against organisations in whose premises slipping accidents have occurred. There are additional financial considerations, such as time lost by injured employees and costs of treating injuries. Situations which require a higher degree of safety in this respect are listed below. It must be pointed out that although situations are mentioned below where bare feet would be the norm rather than the wearing of shoes, this item deals only with safety surfaces in terms of shod feet.

Kitchens

The floor surface is liable to be subject to spillages of water, cooking oil, soap solutions and contamination by food deposits. Condensation may well accumulate, since humidities are likely to be high. The chances of a serious accident are greatly increased because workers may be carrying heavy loads, and falls could result in secondary effects from spillages of hot liquids or collision with other workers and equipment.

Perimeters to swimming pools

Such floor surfaces are subject to flooding with water, and because most users will be barefoot, it is probable that different factors will apply to slipping accidents.

Shower areas and changing rooms

All that applies to swimming pool surrounds applies here, but in addition soap and similar products will be present.

Laboratories

Here the floors are subject to spillages of water and chemicals. Serious accidents may occur if corrosive chemicals or flammable solvents are being carried at the time of the accident.

Stairways

These may be subject to water deposition on wet days, by transfer from shoes, and dripping from umbrellas, coats, etc.

The distribution of forces between the foot and the step while ascending or descending stairs differs from that in walking along the flat. Consequently different types of slipping accident will occur; for example, those involving the sole rather than the heel of the shoe.

Entrances to buildings

On a wet day these will be subject to water deposition from umbrellas and coats and by transfer from shoes. Large quantities of water, sometimes as much as 100 to 250 litres, can be taken into buildings in this way.

Workshops

As well as water deposition, oil spillages can be a problem. However, a further form of contamination occurs here, that of dust. Dust may be a product of woodwork, pottery or a variety of other activities. Hazardous situations are created with respect to slipping by the presence of dusts, and while it may be argued that good housekeeping would reduce the risk, such preventive action does not always take place.

HEALTH AND SAFETY IMPLICATIONS

A large amount of research has been directed to obtaining statistics on slipping, tripping and falling accidents. A report by the Medical Commission states that the number of fatal falls in the UK during 1979 was 5895. This is equivalent to the number of passengers carried in 20 fully loaded jumbo jets. The number of non-fatal occupational falls reported to the Health and Safety Executive was added to the number of accidental falls at home, recorded by the Home Accident Surveillance System to provide a total of half a million injuries from falls. However, a comparison with an American survey suggests that this figure may be only 25% of the actual total, which could be two million falls.

Research in Sweden indicates that half of the injuries resulting from falls occur from slipping incidents. It is clear that the problem of slipping and falling while walking is an extensive one.

FINANCIAL CONSIDERATIONS

1. Medical expenses in treating injuries resulting from falls.
2. Time lost by employees whose absence from work may result in lost production.
3. Legal claims. The Health and Safety at Work Act places a legal obligation on the employer to provide a safe place of work for employees.

Excessively slippery floors represent a dangerous situation and it is no surprise to find that there have been many legal claims made against organisations in whose premises slippery floors are said to be responsible for injuries resulting from slips and falls.

FACTORS AFFECTING SLIPPING

The principal factors involved in slipping and falling as stated in recent research are:

The floor surface

1 The coefficient of friction value of the floor in contact with the sole or heel of the shoe.
2 Presence of foreign substances such as water, oil, dust or food particles.
3 Condition of the floor in terms of wear, damage or changes in gradient.

Individual footwear

1 The coefficients of friction of the sole or heel of the shoe in contact with the floor.
2 The presence of foreign substances on the sole or heal of the shoe.
3 The design, condition or state of repair of the shoe, for example, does the shoe have spike heels or is it damaged by wear?

Physical characteristics of the individual

1 Mode of walking.
2 Distribution of forces within the foot/floor system while walking.
3 Physical condition; for example, lameness.

Mental condition of the individual

1 Sanity.
2 Psychology. For example, the sight of a glossy surface will equate with slipperiness in the minds of many people.
3 Accident proneness.

THE WORK OF THE SHOE AND ALLIED TRADES RESEARCH ASSOCIATION

The Shoe and Allied Trades Research Association (SATRA) carried out a great deal of research into the influence of the coefficient of friction between shoes and floor surfaces with particular emphasis on the differences between the mode of slipping in relation to the soles or heels of footwear.

There are two coefficients of friction predominant in measurement of surface friction. These are:

1 Static coefficient of friction, which exists until the instant that the stationary state changes.
2 Dynamic coefficient of friction, which applies for the duration of slipping.

There has been much discussion as to which coefficient of friction is relevant for the measurement of slip resistance.

SATRA utilised a biomechanical force platform to measure horizontal (H) and vertical (V) force components during walking. These measurements were coupled with stroboscopic time exposure photographs so that the H/V measurements could be related to the position of the foot during walking.

ANALYSIS OF WALKING

The first task in gaining an understanding of the mechanics of slipping is to analyse the process of walking. A step taken during walking may be divided into three main contact phases:

The landing phase

Only the back edge of the heel is in contact with the ground. Evidence suggests that the angle which a heel makes with the ground at first instant of contact is independent of shoe style, but varies between 10° and 30° for different individuals.

The stationary phase.

Both heel and sole are in contact with the ground. No movements between the shoe and floor surface were observed in this phase.

The take-off phase

When only the sole of the shoe is in contact with the floor. As the weight of the body moves forward the contact point moves forward onto the toe of the shoe.

THE H/V TRACE

The graph shown in Fig 1 is the trace obtained as an output of the biomechanical force platform, and shows the variation of the ratio of the horizontal to vertical forces (H/V) acting between the floor and the foot, during the landing and taking off phases of the foot, while one step is being made. The greater the value of H/V, the greater the risk of slipping, because the magnitude of the force of friction between the floor and the shoe is proportional to the magnitude of the perpendicular force between them.

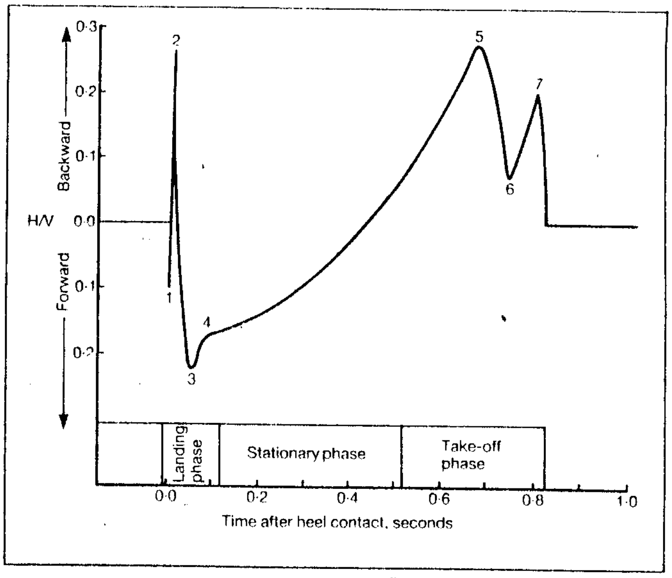

Fig 1: The H/V trace.

Six distinct peaks were observed on the H/V trace. Peaks 1-4 occurred during the landing phase, whereas peaks 5 and 6 were found on the take-off phase. Observations follow on each peak:

Peak 1

Caused by the force of impact of the heel tip against the force platform. This appeared to have a forward direction as a result of the approach angle of the heel to the ground. The peak was found to be dependent upon heel hardness. It was anticipated that the error in H/V values for this peak may be large, owing to its short duration.

Peak 2
Caused by a backward force exerted on the heel of the shoe shortly after contact. No reason for the existence of this force has been suggested.

Peaks 3 and 4
Both in the forward direction and frequently merging together. They are caused by the main forward force which retards the motion of the body and leg.

Although still less than one tenth of a second after heel contact and with only the back of the heel in contact with the ground, the vertical force has risen and a significant proportion of the body weight is being applied through the heel tip.

Peaks 4 and 5
As more of the bodyweight is transferred to this foot, the sole of the shoe contacts the ground. The centre of gravity of the body moves over the now stationary foot and the forward force causing peak 4 decreases. After passing through zero, the H/V again increases due to the backward force exerted by the foot propelling the body forward. The stationary phase ends as the heel leaves the ground, and the shoe flexes and rocks forward until only the toe remains in contact, by which time the H/V level has increased to peak 5.

Peaks 5 and 6
The shape of the trace varies according to the flexibility of the sole of the shoe, and significant errors in H/V occur in this range. For this reason the trace after peak 5 may be ignored.

Prediction of slip occurrence
From the H/V traces there appeared to be four possible occasions during a normal walking step when slip might occur:
(a) Forward slip at peak 1.
(b) Backward slip at peak 2.
(c) Forward slip at peaks 3 and 4.
(d) Backward slip at peak 5.

The theoretical and practical assessments of the above as found by SATRA were as follows:

Forward slip at peak 1
The bodyweight is being transferred to the slipping foot. The forward momentum of the body would make it difficult to remove the weight from that foot to regain balance, and continued slip would be likely to result in a completely irrecoverable situation. This was confirmed in practice, although it was found to be a rare occurrence consistent with an acute angle of approach of the heel tip to the surface, the sole of the shoe not making contact with the floor surface at all. It was considered that slip at peak 1 was influenced by dynamic friction, as the shoe never actually stops moving when it lands.

Backward slip at peak 2
Slip here is unlikely to be dangerous as the force direction quickly reverses to give the sustained forward force at peaks 3-4. This was observed in practice, but was negligible in effect and never noticed by the subjects under observation.

Forward slip at peaks 3 and 4
This was the usual position for slip to occur. Immediately prior to slip, the heel is not quite flat with the surface. The sole is clear of the floor but touches down when the slip starts. It was observed that if the slip exceeded more than 150 mm in length, loss of balance resulted. Such an effect may be related to the acceleration of the foot as it slips forward. If the foot travels faster than the body, the latter can never catch up, but if the reverse happens, then the body is able to overtake the slipping foot, reduce the frictional force, and stop the slip.

It is static friction which influences whether or not slip occurs at peak 3, as the shoe stops moving — albeit for a few hundreths of a second. However, the severity of the slip at peak 3 may well depend on dynamic friction and perhaps on the velocity of the shoe. It is suggested that as the contact time is so short, there may be very little difference between the values of dynamic and static friction.

Backward slip at peak 5
The H/V level is at its highest here and slip is most likely to occur. It is, however, unlikely to be dangerous, as most of the bodyweight has been transferred forward to the leading foot by this time and balance should easily be retained. This was observed in practice. The effect could be dangerous if a subject was walking on an upward sloping surface or on stairs.

SUMMARY

Summarising the SATRA research, it will be observed that irrecoverable slips occur while the foot is moving in the forward direction only and by one of two means. The first involves heel contact only, is virtually irrecoverable once initiated and is definitely influenced by dynamic friction. The second involves heel contact, quickly followed by sole contact as the slip starts. The slip can be stopped under certain circumstances. The slip is influenced by static friction, with the possibility that dynamic friction plays an active role. There seems to be evidence to suggest that the coefficient of static friction is almost equal to the coefficient of dynamic friction at this stage.

The SATRA research did not include any work on the distribution of forces between the foot and the floor surface occurring when the subject is running or walking up or down stairs. It is not unusual for individuals to run in areas where they should normally be walking and this may be a factor in many accidents. It is probable that toe slip is the predominant type of slip when subjects are running. Toe slip is also likely to be prevalent when walking up stairs. Stairs represent a special case in that if they are not constructed to recognised standards, trips can occur as a result of individuals misjudging the height or depth of steps.

EFFECTS OF FOOTWEAR

Coefficient of friction measurements will be affected by the type of heel material used. This is best illustrated by the following table of Slip Index mean values in relation to a vinyl tile, extracted from a research paper by Irvine:

Heel material	Surface condition	
	dry	wet
Leather	5.85	7.63
Grs No 2	8.35	7.75
Foamed grs	6.77	7.36
Pvc - 1	7.75	6.58
Foamed neoprene	9.58	8.71
Foamed hypalon	7.11	5.47
Grs No 1	7.39	8.16
Polyester urethane	7.57	8.04

Grs = Government rubber substitute

The above results were obtained using the Horizontal Slip Meter. Without discussing the relative merits or otherwise of this machine, it will be observed that there is a wide variation in friction values obtained for different heel materials on the same floor surface. The results range from leather at 5.85 to foamed neoprene at 9.58 in dry conditions, and from foamed hypalon at 5.47 to foamed neoprene at 8.71 in wet conditions. Of particular interest is the observation that leather in the dry gives a lower reading than nearly all of the rubber/polymeric materials in the wet. This explains why many people wearing leather soles and rubber heels find floors slippery in dry conditions. The slip is always confined to forward toe slip and is seldom likely to lead to a fall for reasons explained earlier. However, repeated toe slips tend to make a floor tiring to walk upon. The majority of slipping accidents occur with rubber or pvc heels under wet conditions and this is illustrated in that many of the heels examined exhibited a decrease in surface friction under these conditions.

The reason for the increase in slip resistance of leather under wet conditions relates to the microcellular nature of the material. The leather absorbs water at a differential rate and the frictional properties of the material change.

Finally, the results demonstrate the importance of selecting a standard slider material for friction test equipment, in order to ensure that comparative assessments can be made.

SURFACE CONTAMINANTS

Floor surfaces rarely remain in a clean dry condition for very long. Contamination occurs by means of water, dust and oil deposition. Typical contaminants and the means by which they are transferred to the floor surface are as follows:

Water

As far as swimming pool and shower surrounds are concerned, transfer of water from feet or deposition of water are obvious problems. Corridors and offices of buildings are subject to water deposition on wet days by transfer from shoes and by dripping from umbrellas, coats, briefcases, etc. Large quantities of water can be transferred into buildings in this way and while entrance mats help to dry shoes, the problem of dripping from umbrellas, etc, remains. Finally, condensation problems often persist in kitchens along with the increased likelihood of water spillages.

Dusts

Dust deposition is a common problem which in most instances good housekeeping will reduce. However there are situations, such as potteries and workshops, particularly those in which woodworking takes place, where dust deposition will be an ever-present problem. Slipping accidents can occur in dry conditions as the dusts act as lubricants between the foot and the floor surface, and quite substantial changes in surface friction can occur.

Slurries

When certain dusts mix with water, slurries are formed which form highly effective lubricants, and slipping accidents often occur. A slurry can be more slippery than water, as anyone who has slipped on mud can attest.

Oil

Any surface contaminated with oil will clearly be dangerously slippery. For this reason drip trays should always be provided in garage areas and any spillages should be dealt with as soon as they become apparent.

The majority of accidents from slipping occur when there is a loss of heel contact with the floor surface. The amount of heel actually in contact with the surface, at the point where the slipping is likely occur during walking, has been shown to be quite small. Hence, only a small amount of contaminant is required to drastically reduce the slip resistance of the floor surface. It is not therefore necessary for the floor to be saturated with contaminant. Spots of contaminant will be sufficient to bring about substantial reductions in slip resistance in isolated areas.

Hence it can be concluded that the most common cause of slipping accidents is when a substantial decrease in friction levels occurs suddenly, taking the subject by surprise. This can occur by the following means:

1 When one walks from a surface exhibiting a high level of surface friction between shoe and floor surface to a different surface exhibiting a low level of friction.
2 When walking upon a floor surface having isolated areas of surface contamination.

CLEANING

In view of the foregoing, it cannot be overemphasised that it is essential that all safety surfaces should be frequently cleaned in accordance with the manufacturer's instructions, and that they should never be polished.

FRICTION TEST EQUIPMENT

The Transport and Road Research Laboratory portable skid tester

This instrument was designed in the early 50s to measure the slip resistance of road surfaces. A shoe incorporating a spring-assisted rubber slider is attached to the end of a pendulum, which is adjusted to swing through an arc of 180°. The rubber slider is set to traverse a length of 125 - 127 mm over the test surface. The pendulum loses energy in proportion to the dynamic coefficient of friction and reaches its maximum height, which is recorded by an indicator against a scale graduated from 1 to 150. The results obtained under both wet and dry conditions are classified as follows:

Below 20 'dangerous'
20 to 39 'marginal'
40 to 75 'satisfactory'
above 75 'excellent.'

The Council's Scientific Services Branch has used this machine for over 25 years for assessing the slip resistance of floor surfaces, both on site and in the laboratory. Over 3500 results have been obtained on virtually all types of flooring currently available. As most site investigations result from complaints regarding slipping accidents, the branch has a unique opportunity for correlating actual accidents with machine readings.

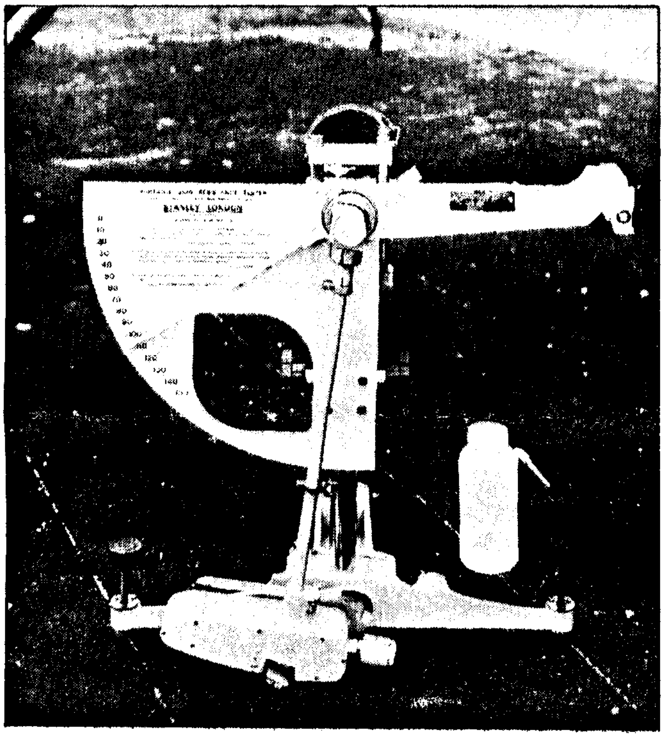

Fig 2: The TRRL portable skid resistance tester.

A frequent criticism of the TRRL skid tester is that the machine is only suitable for testing road surfaces and that the test velocity is too high. However, the machine is based on that developed by P A Sigler, NBS, in the 1940s specifically for evaluating the slip resistance of walkway surfaces. The slider on the machine contacts the floor at an angle of 20°, which is similar to that which the heel makes with the floor surface in normal walking. Moreover, the test velocity of 6 mph is more relevant to the speed achieved in slipping than that of a car skidding. It could well be argued that the machine is more relevant to assessing the slip resistance of floor surfaces than those of roads.

The contact areas of the slider is larger than that of a typical shoe. However, provided that the instrument is used for comparing friction levels on different floor surfaces, coupled with the determination of minimum levels for safe walking, running, etc, this should present no problems.

The type of slip measured here corresponds with that of the landing phase described in the SATRA work mentioned earlier. While SATRA observes that slip at this point is rare. It must be appreciated that slips that result in serious injury are seldom recoverable and this type of slip may be responsible for the more serious accidents that occur.

The NBS — Brungraber portable slip resistance tester
This machine is designed to measure the static coefficient of friction between a representative sample of shoe sole material, such as leather, and a floor surface under true field conditions. It does this by applying a predetermined vertical force,through the shafts of the sensor shoe.

At the start of the test, the carriage is brought forward to a stop position such that the articulated shaft is not vertical, but set at a slight angle towards the back of the tester. This establishes an unbalanced lateral force against the carriage. At the instant that the handle is released and the vertical load is applied, the carriage begins to move back along the travel bars, inducing an increasing lateral load on the shoe as the angle between the articulated shaft and the vertical increases. The tangent of this angle at the moment that the slip occurs is directly related to the static coefficient of friction. The angle is measured by the recording shaft, which is magnetised and drawn along the shaft by attachment to the attraction plate, as the carriage moves backwards.

When slip occurs, the sensor shoe hits the trigger so that the recorder clamp grips the recording shaft, retaining the shaft in its position at the time of slip. The measurement of slip resistance is read opposite a notch in the indicator tube at the front of the recorder clamp, from a linear graduated scale imprinted along the length of the recorder shaft. This value can be directly translated to static coefficient by the use of the calibration chart supplied with the equipment.

Fig 3: The NBS — Brungraber portable slip resistance tester.

The machine has been in use by the Council for seven years and about 1200 results have been obtained during that period. No specific limits have been set for floor coverings, although limits have been set for sports surfaces. The machine seems to relate to toe slip rather heel slip.

SURFACE TYPES

Smooth surfaces

To offer adequate slip resistance, such surfaces would need to possess a high level of surface friction under both wet and dry conditions and to show only a small change when contaminated with oil or dust.

Textured surfaces

These products work on the principle that a slip, once started, will be retarded by the texture of the surface. The texture may be formed by means of an embossing technique during manufacture. Alternatively, additives such as carborundum or silica may be incorporated into the surface.

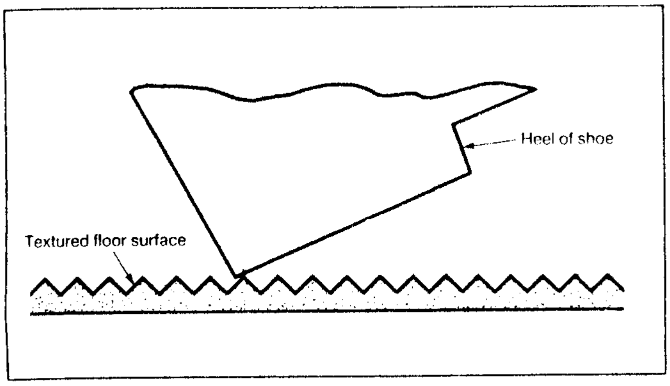

Fig 4: Textured floor surface.

Profiled surfaces

These work on a similar principle to textured surfaces in that they retard slip, with the added advantage that any liquid contaminants will drain away from the contact surface along the troughs of the profile, so reducing the effect of such agents on the slip resistance of the surface.

Ribbed profiles: The heel virtually locks into the ribbed structure when slip occurs. One disadvantage with these profiles is that slips can occur when the heel is moving in the direction of the ribbing.

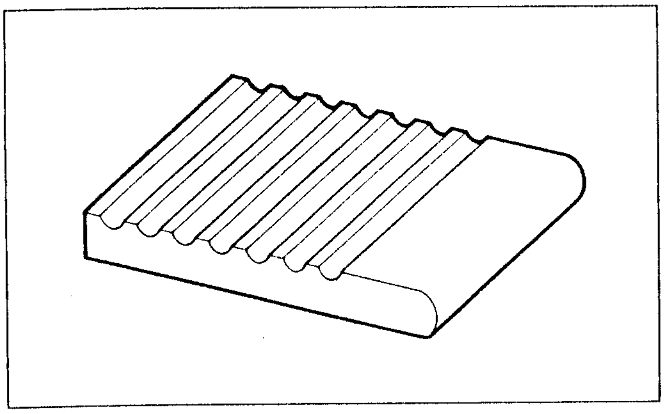

Fig 5: Ribbed profile.

Studded profiles: Due to the problems experienced with ribbed profiles, various studded profiles have been developed.

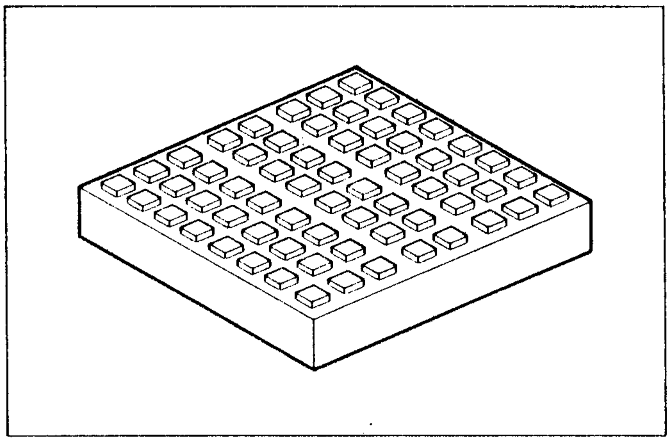

Fig 6: Square studded profile.

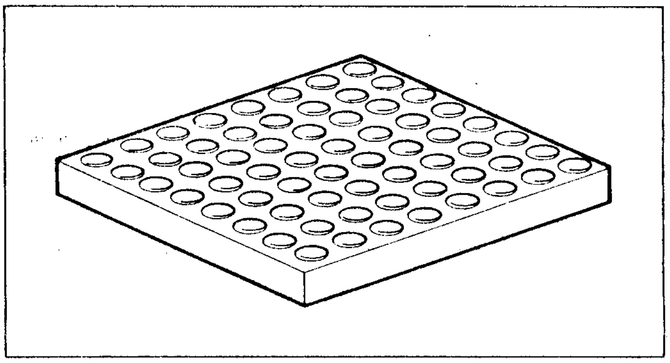

Fig 7: Cylindrical studs.

Diamond and pyramid studded profiles have also been developed for this purpose.

In some instances a textured finish with carborundum aggregate will be applied to the top surface of the profiled structure and afford additional safety with respect to slip resistance.

TEST PROGRAMME

When considering the content of a test programme for evaluation of sheet safety surfaces for situations where high levels of wet slip resistance are required, it becomes apparent that there are many factors other than slip resistance relevant to the walking process. For example, where high levels of surface friction exist, there will also be high levels of surface abrasion. This will have two effects: either the safety surface or the soles of heels of shoes will wear, the relative hardness of the materials involved being the controlling factor.

If the soles or heels wear, then particles of sole or heel material will transfer to the surface of the safety surface and dirt will gradually build up on the surface of the flooring. For this reason it will finally be necessary to determine the ease with which the product can be cleaned back to its original condition.

The product will also need to satisfy the following requirements:
(a) be dimensionally stable
(b) possess low flammability
(c) be stable to the effects of uv light
(d) be resitant to the effects of various chemical compositions such as detergents, swimming pool water and bleach
(e) be flexible at low temperatures
(f) support no bacterial or fungal growth.

TEST PROCEDURES

References in this section to test methods, for example FO1. 14, relate to methods included in "Testing Specification F 8316 (Safety Floorings)" of the Scientific Services Branch Polymeric Materials Group.

Description

1.1 Colour, colours of the wear coat, pattern and the coating of the base layer.
1.2 Manufacturer's shade number.
1.3 Available colours — record all colour shades available, along with the respective manufacturer's shade numbers.
1.4 Whether the pattern is printed, embossed, infilled, etc.

Dimensions

2.1 Measured width of the product — as described in Test Method F01.14 (based upon BS 3261 Part 1: 1973, Appendix C).
2.2 Available sizes of the product — as described in the manufacturer's literature.
2.3 Squareness of tiles — as described in Test Method F01.20 (based upon BS 3261 Part 1: 1973 Appendix E). There shall be no gap greater than 0.15 mm between the sides of the tile and the arms of the jig.
2.4 Measured thickness — as described in Test Method F01.08 (based upon BS 3261 Part 1: 1973, Appendix B). the mean thickness shall not differ by more than 0.13 mm from that specified. The range shall not exceed 0.20 mm.
2.5 Curling — as described in Test Method F01.18 (based upon BS 3261 Part 1: 1973, Appendix K). The amount of curling shall not exceed 0.75 mm.
2.6 Weight per unit area — as described in Test Method F02.05. A sample of regular shape, not less than 100 mm × 100 mm is weighed. Results expressed in kg/m^2.

PHYSICAL PROPERTIES

3.1 Residual indentation — as described in Test Method F06.15 (based upon BS 3261 Part 1: 1973, Appendix F). The residual indentation shall not exceed 0.10 mm.
3.2 Scratch resistance — as described in Test Method F04.11 (based upon BS 3261 Part 1: 1973, Appendix N).
3.3 Schmidt hammer — as described in Test Method F04.07. The Schmidt hammer, model LB, was used for assessing the differences in resilience of the products, and the values recorded were direct scale readings.
3.4 Dimensional stability — as described in Test Method F01.21 (based upon BS 3261 Part 1: 1973, Appendix J). The change in linear dimensions shall not exceed 0.4% for sheet materals and 0.25% for tiles. After the test the specimens shall show no signs of curling.
3.5 Moisture movement — as described in Test Method F01.24 (based upon BS 3261 Part 1: 1973, Appendix L). The change in linear dimensions shall not exceed 0.4%.
3.6 Low temperature flexibility — as described in Test Method F11.17 (based upon BS 3261 Part 1: 1973, Appendix G1). The material shall not break, crack or show any signs of failure.
3.7 Deflection — as described in Test Method F06.13 (based upon BS 2592: 1973, Appendix B). The maximum deflection shall be recorded. The material shall not break, crack or show any signs of failure.
3.8 Elastic product — as described in Test Method F06.02 (based upon BS 3261 Part 1: 1973, Appendix P). The mean product of tensile strength and elongation shall not be less than 2 MJ/m^3.
3.9 Heat ageing and exudation — as described in Test Method F10.12 (based upon BS 3261) Part 1: 1973, Appendix M). No exudation of plasticiser shall be apparent nor shall there be any change in appearance. The material shall not break, crack or show any signs of failure.
3.10 Abrasion resistance — as described in Test Method F08.01. The Taber wear index is expressed in mg/1000 revolutions, using the Taber abrader fitted with S-35 wheels under a load of 1 kg per wheel.
3.11 Ply adhesion — as described in Test Method F06.03 (based upon BS 3261: Part 1: 1973, Appendix H). Adhesion between the laminae in any test piece shall not be less than 1 kN/m.

OTHER PROPERTIES

4.1 Slip resistance — as described in Test Method F07.01. The slip resistance of the wearing surface is determined using the Transport & Road Research Laboratory portable skid resistance tester.
4.2 Coefficient of static friction — as described in Test Method F07.02. The coefficient of static friction is determined using the NBS Brungraber Slip-Tester, shod with the standard leather foot.
4.3 Colour fastness — as described in Test Method F09.01. the apparatus used to assess the effect of light on the samples is the Xenotest 150. The test is carried out in accordance with BS 1006 Method B02, the results being expressed on a 1-7 scale. Any result below Blue Wool Scale 6 shall be described as unsatisfactory.
4.4 Bactericidal/fungicidal properties — as described in Test Method F10.19. The samples shall not exhibit any bacterial or fungal growth.
4.5 Ease of cleaning — as described in Test Method F11.08. The samples shall not exhibit any change in appearance at the completion of the test.
4.6 Chemical resistance — as described in Test Method F10.02. The samples shall not exhibit any change in appearance at the completion of the test.
4.7 Flammability — as described in Test Method F11.01. The effects of a small source of ignition are determined by the methods given in BS 4790 (classified according to BS 5287). Any result in excess of a 'low' radius of effects of ignition shall be recorded as unsatisfactory.