MEASUREMENT OF SLIP RESISTANCE OF RESILIENT FLOORS PRINCIPLES AND EVALUATION

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1. GENERAL

1.01 This section reviews the factors affecting the slip resistance of resilient floors and various methods which have been used to evaluate this property. A method for appraising slip resistance by means of the foot is described. Instructions are given for obtaining numerical values representing comparative slip resistance by means of a polishing machine brush test.

1.02 This section is reissued to include updated testing technology (**4. EVALUATION WITH THE FOOT**). The text is also slightly modified in other areas.

1.03 The methods described are particularly designed for checking the slip resistance of resilient floorings maintained with wax or resin finishes. The resilient floorings include:

Asphalt tile

Linoleum—Sheet and tile

Rubber—Sheet and tile

Vinyl asbestos tile

Vinyl—Sheet and tile.

The maintenance coatings covered are the following Bell System standards:

ANTI-SLIP FLOOR FINISH F-5

ANTI-SLIP FLOOR FINISH, BUFFABLE F-6

FLOOR FINISH F-7

FLOOR WAX W-8.

1.04 Slip resistance consists of two components: (1) static friction, the slip resistance of the surface, and (2) kinetic friction, the slip resistance of the body of the film. The first represents the resistance to a flat surface, such as the sole of the foot, and is largely controlled by the tackiness of the film. The second represents the resistance to a point contact, such as the heel of the shoe as it meets the floor, and measures the shear resistance of the film once a slip has started. Both types are important. The resistance to the sole of the shoe is the type most obvious to general personnel. It prevents slips from starting. The shear resistance determines whether the slip, once started, is arrested or results in a fall.

1.05 Testing for slip resistance has certain psychological as well as practical advantages. For example, the floor may have a high gloss as a result of a recent waxing or polishing which may give the occupants the erroneous impression that the floor is slippery. A test with the machine can demontrate that this is not so and that the floor has a satisfactory slip resistance. If a slip and fall has occurred, the test can determine whether or not action on the part of the building service personnel is required.

1.06 The maintenance of resilient floors by waxing or resin application is covered in the following sections:

Section 770-130-060—Resilient Floors— Finishes—Care

Section 770-130-070—Floor Waxing.

2. FACTORS AFFECTING SLIP RESISTANCE

2.01 Slip resistance is affected by many factors including the nature of the protective finish, the character of the underlying floor, the preparation of the floor and the application of the coating, climatic and atmospheric conditions, traffic conditions, the age of the film, and the type of footwear worn by the personnel.

2.02 The finishes used to maintain resilient floors represent a balance. For example, to achieve slip resistance, durability and ease of maintenance must be sacrificed to some extent. The Bell System floor finishes have been checked for static coefficient of friction by the James Machine using the procedures outlined in ASTM D-2047. The Bell System floor finishes tested by this method have a minimum coefficient of friction of 0.50 which meets the friction standard established by Underwriters' Laboratories. They also comply to Rule 5 on "The use of terms slip retardant, slip resistant or terms of similar import" of the Proposed Trade Practice Rules for the floor wax and floor polish industry as issued by the Federal Trade Commission. However, while the Bell System standard floor products are safe, they may vary somewhat in slip resistance. The least slip resistant is the W-8 wax which has a high carnauba wax content with a sufficient quantity of "Ludox", a colloidal silica, to make the product sufficiently slip resistant to meet the 0.50 minimum coefficient of friction.

2.03 The density and resilience of the underlying flooring has a marked effect on the slip resistance of the wax or resin film. In general, the commonly used flooring materials run in the following order of resilience and slip resistance, from least to most: asphalt tile, vinyl asbestos, vinyl tile, linoleum, and rubber. Appreciable differences, however, can be expected between different brands, grades, and colors of the same type flooring. In general, floorings tend to harden on aging with a corresponding loss in slip resistance.

2.04 To achieve satisfactory slip resistance, it is essential that the floor be properly cleaned and rinsed free from soap residues. Mops that are used for wax must not be subsequently used for Anti-Slip Floor Finish. Failure to observe this precaution may result in a fast, ie, slippery floor. In general, two coats give better slip resistance than a single coat. In the case of wax, buffing tends to improve the slip resistance. This is particularly true of freshly applied films where moisture is retained in the film for some time even though the wax appears to be dry. The buffing dries out the film.

2.05 All of the Bell System maintenance coatings are water emulsions. The residual films on the floor are accordingly affected by atmospheric conditions, particularly humidity. Consequently, they tend to be more slip resistant during the more humid summer months than during the winter when heating systems are in operation and humidity levels are low. Similarly, the same wax will be appreciably more slip resistant in the South where it is hot and humid than in the North where it is cold and dry.

2.06 Traffic conditions which tend to wear the film thin decrease slip resistance. On the other hand, ground-in abrasive dirt increases the slip resistance. Also, as the coating ages, it tends to oxidize, harden, and become less slip resistant.

2.07 The presence of tracked-in or spilled water greatly decreases the coefficient of friction and creates a hazardous condition. All such water should be promptly mopped up. When the soles of the shoes are damp, the coefficient of friction between the soles and the wax film is appreciably decreased. This, however, is not true of Anti-Slip Floor Finish.

2.08 The type of footwear has a major bearing on slip resistance. Low-heeled shoes with a broad contact area ensure maximum safety. For this reason, slips and falls among men are comparatively rare. Under dry conditions, much higher antislip coefficients are provided by rubber heels than leather heels. Under wet conditions, this difference largely disappears.

2.09 Care should be exercised to minimize, so far as possible, the difference in slip resistance between parts of the same floor or adjacent floors. If the personnel are not aware of this difference, there is an element of surprise due to the sudden change in the slip resistance of the floor. A change in slip resistance requires a change in pace.

3. SLIP TESTING PROCEDURES

3.01 Many different devices and methods have been proposed for the measurement of slip resistance of floors. These can be divided into two classes: (1) the determination of the coefficient of static friction between the floor surface and a test piece, usually a leather sole, and (2) the measurement of kinetic or dynamic friction. The first evaluates mainly the surface resistance of the film, while the second measures to a considerable degree the shear resistance of the coating. In general, the static devices have been based on the inclined plane or oblique thrust principles. Kinetic apparatus have varied from pulling a weighted object across the floor and measuring the resistance by means of a spring scale, to a device that propels a steel puck across the floor, the distance slid being a measure of the slip resistance.

3.02 The best known static friction device is the James machine developed by the Underwriters' Laboratories. It operates on the oblique thrust principle. It consists of a 3-inch square test shoe, shod with a piece of sole leather that contacts the test surface. A vertically downward load of 75 pounds is applied through a 10-inch arm that is hinged to the shoe. By a controlled mechanism, the angle of the test arm to the vertical is progressively increased until the horizontal force becomes sufficient to cause the test piece to slip. By means of a chart, the coefficient of friction is automatically recorded. A minimum safe coefficient of friction of 0.50 has been established by the Underwriters' Laboratories. All Bell System floor finishes have been tested on this equipment and meet or exceed the minimum requirement.

3.03 The most widely used kinetic tester is the Sigler machine developed by the National Bureau of Standards. It consists of a weighted pendulum which sweeps a leather heel across the test surface. The degree to which the swing is retarded by the resistance of the treated flooring gives a direct measure of the antislip coefficient.

3.04 The James and Sigler machines are essentially laboratory equipment that do not lend themselves readily to field testing. They are expensive, not easily transported, and require exact adjustments to obtain dependable results.

3.05 Experience indicates that the best methods for checking the slip resistance of floors in the field is by practical evaluation with the foot and by means of a polishing brush test as described in the following paragraphs.

4. EVALUATION WITH THE FOOT

4.01 Both static and kinetic frictions can be evaluated with the sole of the shoe, preferably a leather sole. Before making the tests, the sole of the shoe should be dry and the bottom and outside edge of the sole should be wiped clean with a cloth or paper towel. Place the "test" foot in front of you at a distance equal to a normal step. Raise the heel of the "test" foot off the floor and apply a forward pressure by leaning forward and shifting your body weight to the "test" foot. The amount of pressure needed to cause the "test" foot to start sliding is a measure of the static friction of the floor surface. Kinetic friction or shear resistance is measured in the same manner except that only the outside edge of the sole is used. With the "test" foot in position and the heel raised off the floor, turn the foot so that only the outside edge of the sole is resting on the floor. The sole of the shoe should be at an angle of approximately 30 degrees with the floor. How readily the edge of the sole slides along the surface of the floor, as pressure is applied, is a measure of its shear resistance.

4.02 A second measure of slip resistance can be achieved by standing with all of the body weight on the ball of the "test" foot and then twisting the body to cause a pivoting action. The ease at which the foot starts to turn is a measure of static friction and how freely the foot continues to turn is a measure of kinetic friction.

4.03 The person testing the floor then appraises the slip resistance of the coating based on his combined impression of the two slip components. It is helpful to use a rating system in recording the results, such as the following: (1) very fast, (2) fast, (3) satisfactory, (4) slow, (5) very slow. It is desirable to have a number of people engage in the rating and make independent appraisals. After some experience, surprisingly close agreement can be obtained.

5. POLISHING MACHINE METHOD

5.01 This test operates on the principle that the amount of current drawn by a polishing machine varies directly with the amount of work

performed. If the brushes are not in contact with the floor, only sufficient current is required to overcome the frictional resistance of the machine itself. If the brushes are placed on the floor, additional current is required to overcome the frictional resistance of the floor. If the floor is coated with a slippery wax, less current is required than if the wax is highly slip resistant. Accordingly, if an ammeter is connected in series with the polishing machine to measure the current being consumed, a direct measure of the slip resistance of the floor is obtained.

5.02 To obtain significantly different readings, a lightweight 2-brush machine should be used. An appropriate type of machine would be available through the household appliance outlets. The brushes should be removable. Any suitable ammeter, preferably with a range of 0-5 amperes, can be mounted on the handle and wired in series with the hot lead. Only a qualified person should make this modification.

5.03 Before making the test, the machine must be run for a period of about 10 minutes to thoroughly warm it up. This is done by laying the machine on its back and running it with the brushes in the air. The ammeter readings will slowly decrease as the machine warms up. Finally, the pointer will remain steady. A typical value when running free is 1.6 amperes. It is advisable to take a free reading before and after any set of tests to be sure there has been no radical change in electrical current.

5.04 In making the test, the brushes are in contact with the floor and the handle is laid in a horizontal position so that the weight on the brushes is constant. Because of the 2-brush construction, very little effort is required to prevent the machine from traveling. Do not apply any downward pressure on the handle in holding the machine in place. Allow a few seconds for the needle to steady, then read. Usually abut 10 seconds are sufficient. Prolonged polishing in one spot will create heat and give abnormally high results. Any such reading should be discarded. It is usually advisable to take about 10 readings at different locations and average the results.

5.05 A separate set of brushes should be used for each type of wax or finish. They need not be cleaned between each test but periodically, they should be "dry cleaned" by pressing a flat stick, such as a ruler, against the brushes as they rotate. If the same set of brushes are going to be used for both wax and resin finishes, the brushes must be thoroughly cleaned when changing from one type of coating to another. A carryover of wax on the brushes will seriously lower the reading on a resin film. The brushes should be thoroughly washed with a 1 to 16 solution of liquid floor cleaner (C-4) and allowed to dry. If time is pressing, the brushes can be cleaned with C-12 solvent cleaner. In the latter case, make sure there is adequate ventilation. The machine should not be used for other purposes nor should it be stored resting on the brushes.

5.06 The polishing machine test has certain advantages. The equipment is inexpensive, readily available, and easily transported. It is simple to operate and suited for testing in the field. The results agree well with complicated laboratory tests and practical foot evaluations in that waxes are rated in the same order. Its greatest value is for checking floors where complaints have been received that the floor is fast or where actual slips and falls have occurred.

5.07 The results should be considered comparative in character and may vary somewhat from machine to machine. Each location may have to establish its own par values. As a guide, readings in the range of 2.6 to 3.0 are typical for the standard Bell System floor products.

6. SAFETY PRECAUTIONS

6.01 The following paragraphs summarize measures that should prove helpful in minimizing the possibility of slipping and falling accidents on resilient floors.

6.02 Before applying wax or resin finish, be sure that the floor has been thoroughly cleaned and rinsed.

6.03 In cutting over from wax to resin, or from resin to wax, be sure all residues of the old finish have been thoroughly removed.

6.04 In applying Anti-Slip floor finish, do not use mops that have previously been used with floor wax or liquid floor cleaner. Separate mops should be used for each product.

6.05 Avoid too little or too much wax. In general, following reconditioning cleaning, two coats of full strength will be found to provide the optimum amount.

6.06 So far as practicable, uniform coatings should be maintained over the entire floor. Uneven coatings may produce different resistances to slipping and create a hazardous condition.

6.07 Avoid the use of different types of coatings having different coefficients of friction on the same floor, or so far as practicable on adjacent floors.

6.08 Following the application of wax or a floor finish, allow the floor to dry thoroughly before being opened to traffic. For maximum safety, several hours drying time is preferable. In no case should the floor be opened to traffic with less than 1/2 hour drying time. In such cases, if wax has been used, the floor should be buffed before traffic is permitted.

6.09 Periodic polishing tends to keep wax coatings alive and aids in maintaining maximum resistance to slipping. Under certain conditions, a damp mopping prior to the buffing will be found helpful. These suggestions do not apply to the F-5 and F-7 floor finishes.

6.10 Since resilient floors are slippery when wet, floor mats should be placed at entrances during wet weather to prevent tracking water or snow into the building. The mats should be of a type and size to provide adequate foot wiping to dry the soles of footwear.

6.11 Keep floors clean and dry. Mop up immediately any liquids that are spilled on the floor. Sweep up as soon as practicable such objects as pencil leads, paper clips, rubber bands, and cigarette butts that can create a hazardous condition underfoot. Encourage occupants to pick up such litter whenever noted.

6.12 Block off floor areas that are being cleaned or waxed so that persons cannot inadvertently walk on them. Place caution signs where they may be readily seen and leave them in place until the floor is thoroughly dry.

6.13 If a slip and fall occurs, study the various factors which may have contributed to the accident to avoid similar mishaps in the future. In making these analyses, cooperate with other departments who may be concerned.

6.14 Use only the waxes or finishes that are recommended for Bell System use. These standards are delivery-inspected and checked periodically for slip-resistant properties.