

Prevention of Slips, Trips and Falls: A Systems Approach

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Oregon Governor's Occupational Safety & Health Conference, March 10, 2009

Session Agenda

- Causes of slips, trips and falls
- Managing safety: a continuum
 - Hazards: slipperiness, inside/outside, stairs
 - Flooring, treatments and coatings
 - Housekeeping and maintenance
 - Slip-resistant footwear
 - Mats and runners
 - Slipperiness assessment





Causes of Slips, Trips and Falls

- Tribology
- Ergonomics
 - Aging population
 - Vision
 - Reaction time
 - Strength
- Biomechanics
- Psychology
 - Distractions
 - Transitions
 - Perceptions of slipperiness
- Others



Gary Larson's The FarSide®



Tribology

- The study of the interaction of sliding surfaces
- It includes three subjects:
 - Friction
 - Lubrication
 - Wear

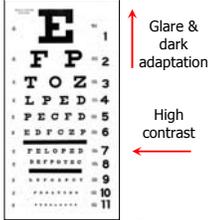





The screenshot shows the ASME Digital Library interface for the Journal of Tribology. It includes a navigation menu on the left with options like 'Purpose and Scope', 'Abstracts & Indexed In', and 'Program Info'. The main content area displays the journal title, a list of topics (Friction and Wear, Fluid Film Lubrication, etc.), and links for 'Accelerated Articles Issue (Open)' and 'Current Issue'. It also provides contact information for the editor, Michael O. Bryant, and the journal's ISSN and CODEN.

Age and Vision

- Range of visual accommodation; visual detection of hazards
- Loss of contrast sensitivity (diabetes, other illnesses)
- Poor dark adaptation (slow/incomplete)
- Less color sensitivity
- Glare sensitivity (cataracts, reduced glare recovery >age 50)



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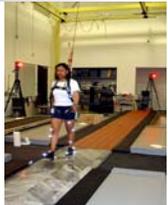
Perceptions of Slipperiness Research:



Heel Slip (DiDomenico et al., 2007)

"Most people were not sensitive enough to detect small differences in slip distances and underestimated the slipperiness of the floor surface."

Slips under 30 mm not perceived



Visual Cue (Lesch et al., 2007)

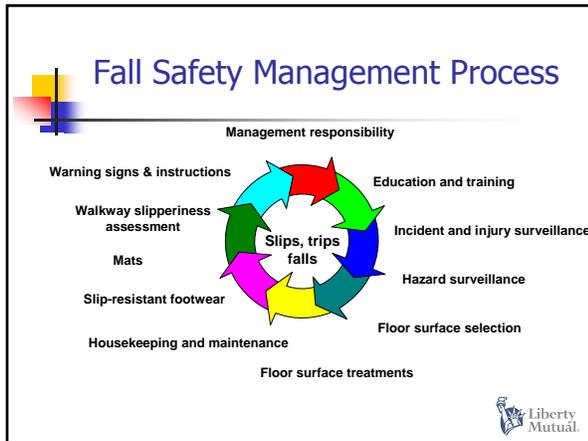
"A significant relationship was observed between visual cues to slipperiness [COF, reflectiveness]"

Liberty Mutual.



"Humans cannot be relied upon to detect slippery floors and take corrective action. Installing the best flooring and keeping it clean and as dry as possible is key to prevention."







Facility Design: Slip-Resistance

- U.S. Access Board
 - Americans With Disabilities Act Accessibility Guidelines (ADAAG)-1991
 - Section 4.5 *Ground and Floor Surfaces*, 4.5.1 *General and Appendix Note A4.5.1 – Floors shall be slip-resistant, 0.6 SCOF for access routes and 0.8 SCOF ramps (non-mandatory). No mention wet or dry.*
 - ADA-ABA Accessibility Guidelines-2003
 - Based on ANSI/ICC A117.1- 2003, *Standard on Accessible and Usable Buildings and Facilities* (in revision)
 - Chapter 3, *Building Blocks*, section 302 *Floors or Ground Surfaces* - Floors shall be slip-resistant. No Appendix, no definition.



Facility Design: Slip-Resistance

- ANSI A117.1 *Standard on Accessible and Usable Buildings and Facilities*
 - Building Codes and Commentary
 - References 0.5 SCOF and US Access Board Flooring Technical Bulletin.
 - ASTM/ANSI A1264.2
 - Revision: ASTM F802, *Selection of Certain Walkway Surfaces When Considering Footwear Traction.*
 - ANSI A1264.2, 0.5 dry only.






The landmark Americans with Disabilities Act (ADA), enacted on July 26, 1990, provides comprehensive civil rights protections to individuals with disabilities in the areas of employment (title I), state and local government services (title II), public accommodations and commercial facilities (title III), and telecommunications (title IV). Both the Department of Justice and the Department of Transportation, in adopting standards for new construction and alterations of places of public accommodation and commercial facilities covered by title III and public transportation facilities covered by title II of the ADA, have issued implementing rules that incorporate the Americans with Disabilities Act Accessibility Guidelines (ADAAG), developed by the Access Board.

UNITED STATES ACCESS BOARD
A FEDERAL AGENCY COMMITTED TO ACCESSIBLE DESIGN



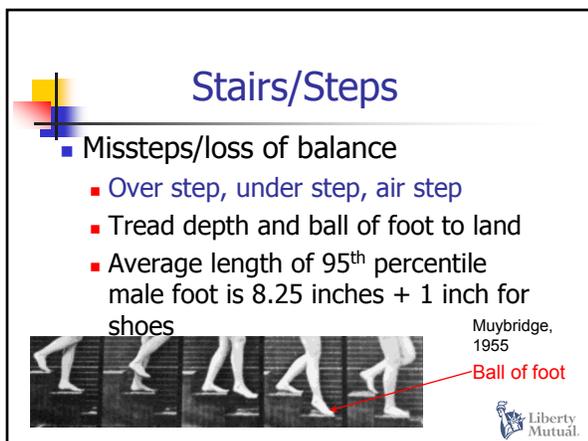
TECHNICAL BULLETIN: GROUND AND FLOOR SURFACES

3.5 Definitions. Accessible Route.
A continuous unobstructed path connecting all accessible elements and spaces of a building or facility. Interior accessible routes may include corridors, floors, ramps, elevators, lifts, and clear floor space at fixtures.

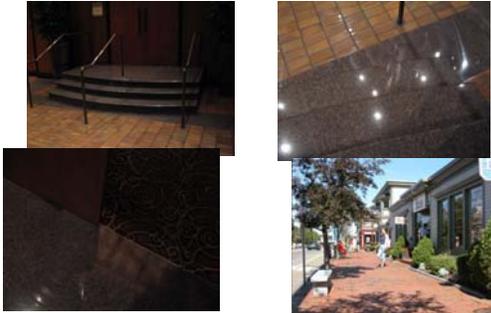
Why are surface characteristics specified?
Over twenty-seven million Americans report some difficulty in walking. Of these, eight million have a severe limitation; one-fifth of the population is elderly. Ambulatory persons with mobility impairments--especially those who use walking aids--are particularly at risk of slipping and falling even on level surfaces. Preliminary research conducted for the Access Board in 1990 through the Pennsylvania Transportation Institute at The Pennsylvania State University compared the slip-resistance needs of persons with mobility impairments and those without disabilities walking on level and ramped surfaces both indoors and out. Findings from this limited human-subject testing confirmed that individuals who have gait and mobility difficulties make greater demands on the walking surfaces of







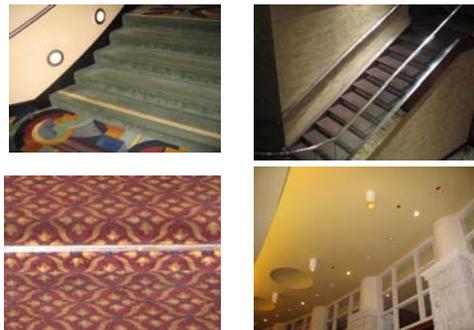
Stair Visibility/Transitions:
Landings, Lighting



Stair Visibility/Transitions:
Landings, Lighting



Stair Visibility/Transitions:
Landings, Lighting



Treads: Slips and Falls

- "Steps and treads shall be of slip-resistant material" (NFPA 101, ASTM F802 revision draft)
 - Extend whole tread
 - Nosing strips okay
- Nosings shall extend not more than 1.5" (ADA-ABA)



Treads: Slips and Falls



- Potential problems
 - Slippery nosing
 - Pitch angle too steep
 - Check tread widths and riser heights



Rubber Flooring and Stair Treads



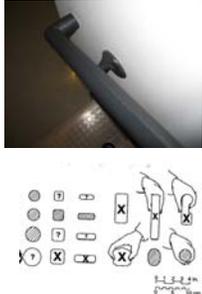
Nora Flooring: Norament® 925
Neutral cleaner
Do not polish or wax

Polished and waxed:
Potential problem wet



Handrails

- Both sides of stairs, full length of stairway.
- 34" high min. and 38" high max.
- Extend 12" at top of stair, one tread depth from bottom step at bottom.
- Hand rail 2 1/4" diameter
- Clearance 1 1/2" away from wall



Handrails



Stair Rails: Open Stairways

- Install a two-rail system; a top rail at 42 inches and a second handrail at 34 inches minimum and 38 inches maximum vertically above stair nosings
- Protect the open area under the top rail to the stairway steps by installing a fixed barrier. **Fixed barriers preferred to balustrades.**
- Handrails both sides preferable; required right side only descending; stair widths < 44 inches.





Stairway Design

- ANSI A117.1: all steps on a flight of stairs shall have a uniform riser height and uniform riser depth. Riser height shall be **4 inches** (10.2 cm) minimum and **7 inches** (18.0 cm) maximum. Minimum tread depth shall be **11 inches** (28.0 cm) minimum.
- International Building Code (IBC): riser height **4 to 7 inches** (10.2 to 17.8 cm) and tread depth **11 inches** (28.0 cm) minimum (exclusive of overhang).
- ADA-ABA formally ADAAG: all steps shall have uniform riser heights **4 inches** minimum and uniform tread widths. Stair treads shall be no less than **11 inches** (28 cm) wide, measured from riser to riser.





NFPA 101 Life Safety Code - Chapter 7, Means of Egress, section 7.2.2 Stairs.

- New stairs: Maximum riser height 7 inches (17.8 cm) and minimum 4 inches (10.2 cm). Minimum tread depth 11 inches (27.9 cm).
- Variation in excess of 3/16 inch (0.5 cm) in the depth of adjacent treads or in the height of adjacent risers shall be prohibited.
- For new stairs exceeding 6 feet 3 inches wide (190.5 cm), handrails shall be provided within 30 inches (76 cm) of all portions of the required egress width.
- For existing stairs, handrails shall be provided within 44 inches (112 cm) of all portions of the required egress width.





Stairway Design

ANSI A1264.1 Safety Requirements for Workplace Walking/Working Surfaces and Their Access; Workplace, Floor, Wall and Roof Openings; Stairs and Guardrails Systems (on-line)

- Handrails-Fixed Industrial Stairs (section 7.2.1)
 - Both sides enclosed ≤ 44 inches wide: at least one handrail on right side descending. If feasible, both sides. Open stairway must have stair-railing regardless.
 - Both sides enclosed 44 – 88 inches wide: two handrails and if open stair-railing.
 - Both sides enclosed > 88 inches, handrail both sides and if open stair-railing both sides AND intermediate handrail.
 - Any stairway over 75 inches needs an intermediate handrail so that all portions of stairway are within 30 inches of a handrail



One and Two Step Entrances

- Avoid if you can
- Risers follow guidelines for stairs
- Possibly install hand rail
- Not ADA compliant-might need ramp
- Use safety yellow on step edges



Fall Safety Management Process



Floor Safety Facts

- Most dry surfaces are slip-resistant (0.5 SCOF or higher)
- Slips/falls occur when floor is wet and/or contaminated (dust, grease, oil etc.)
- Transitions from "non-slippery" to "slippery" floors are a problem (including spills)
- Slipperiness increases over time when floor is worn



Flooring Selection

- What kinds of spills are likely?
- What are the sanitary requirements?
- Will the area have heavy traffic?
- Is it normally a wet environment?
- How will the floor be cleaned?
- Are aesthetic effects a concern?
- Inside or outside?



What Is "Slippery"?

- <0.5 (relatively slippery), 0.5 - 0.6 (generally acceptable), >0.6 (relatively not slippery).
- Most studies show that people can walk comfortably and safely on surfaces with a coefficient of friction greater than 0.4, but 0.5 offers an additional safety factor*. This is called a Slip-Resistant surface.
- Wet or dry

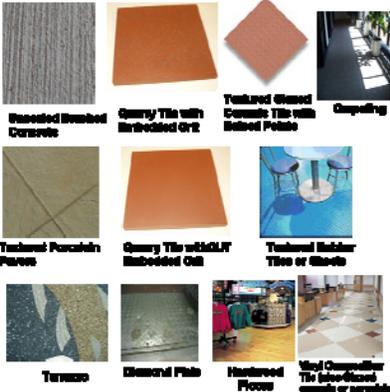
* Miller, J. M. (1983). Slippery work surfaces: Towards a performance definition and quantitative coefficient of friction criteria. *Journal of Safety Research*, 14, 145-158.



Flooring

- Lobbies
- Restrooms
- Kitchens
- Cafeteria
- Stairs/steps
- General office
- Manufacturing





Performance

- Excellent to Good slip-resistance, BOTH wet and dry.
- Good slip resistance dry, Fair wet.
- Good to Fair slip resistance dry, Poor wet.

Transitions-Lobby Flooring



Granite to Terrazzo

From outside

Floor Slip Test Results

Slipmeter used: Brungraber Mark II (PIAST)
ASTM Test Method: F1677-05

Design Choice	Slip resistance* Dry	Slip resistance* Wet	Loss Prevention Recommends?
Existing Terrazzo	0.38	.08	No
Existing Northern Green Flamed Granite	0.67	0.51	Yes More typical of normal wear and tear
Proposed Option Northern Green Gem 8 Granite	0.83	0.62	Yes New sample never in service
Proposed Option Giallo Vincenza Flamed Granite	0.93	0.81	Yes New sample never in service
Proposed Border Absolute Black Flamed Granite	1.05	0.95	Yes New sample never in service

* Interpretation of results: Slip resistance value: 0.5 or less (relatively slippery), 0.5 - 0.6 (generally acceptable), 0.6 or higher (relatively not slippery)

Additional Considerations

- Restrooms
 - Soap dispensers by sink
 - Paper towel dispensers by sink; not behind
- Cafeteria
 - Same as above
 - Housekeeping; spill control
 - Floor cleaning protocol




Coatings

Grit Type (and Hardness)

Silicone Carbide	Aluminum Oxide	Quartz
9.5	9.0	7.0

Bonding Material

Epoxy, urethane, acrylic	Paint	Adhesive Sheets
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Application

Blend	Broadcast
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Cost/Durability

High-----Low

28 11.45AM

Paints and Coatings-Grits

- Grits: aluminum oxide, sand, others

Grit Diameter (inches)	Grit Diameter (microns)	Mesh Size (smaller is bigger)	Examples
.008 - .006	254-145	60-80	Restaurants and food preparation
.014 - .008	356-254	40-60	Food processing
.027	686	20	Manufacturing workstations
.073 - .053	2210-1346	8-12	Vehicle Ramps



Laboratory Test Standards

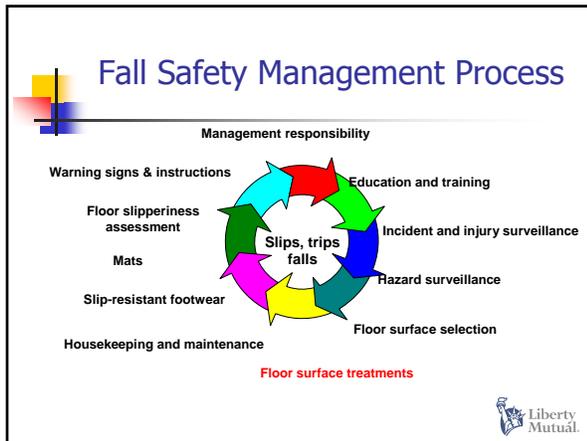
- ASTM C1028-07 *Standard Test Method for Determining the Static Coefficient of Friction of Ceramic Tile and Other Like Surfaces by the Horizontal Dynamometer Pull-Meter Method*
 - New tiles only
 - Cited frequently by flooring manufacturers
 - Not representative of tile in service over period of time




Flooring Summary

- Beware of laboratory product testing COF test data. Not real world.
- Floors behave differently wet, greasy and worn. *Glazes wear over time.*
- Evaluate flooring and finishes by slip-resistance wet, dry, and durability over time.
- Rougher the floor the more slip-resistant wet
- **Keep floors as clean and dry as possible!**





Floor Treatments

- Chemical etching
 - Ceramic tile, quarry tile, natural stone, concrete
- Waxes, polishes
 - Limitations of COF data offered by manufacturers
 - Durability an issue
- Coatings (acrylic, urethane)
 - Grit issues similar to epoxy discussion

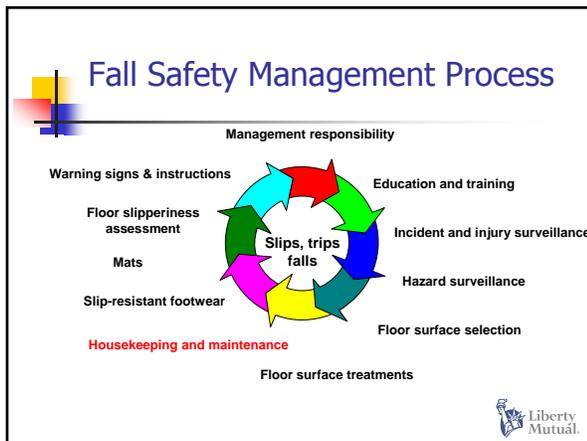
Laboratory Test Standards

- ASTM D2047-04 *Standard Test Method for Static Coefficient of Friction of Polish-Coated Floor Surfaces as Measured by the James Machine*
 - Dry surfaces only
 - 0.5 SCOF or higher "slip-resistant"
 - Very frequently cited by flooring and treatment manufacturers

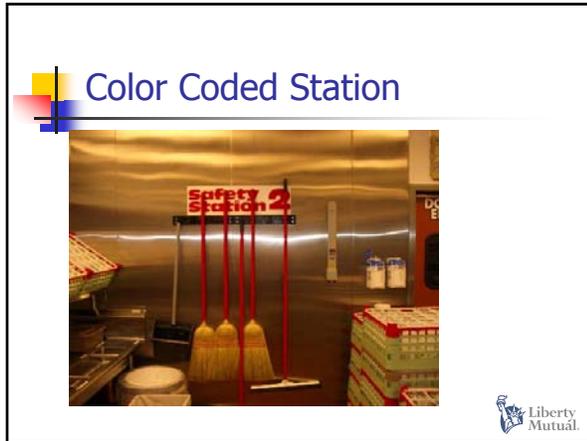
Laboratory Test Standards

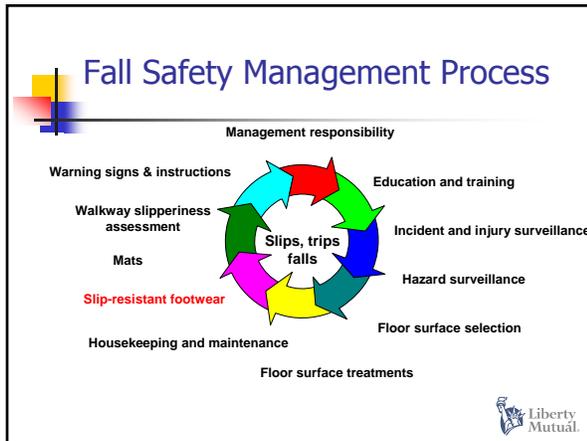
- UL 410 - 2006, *Standard for Slip-Resistance of Floor Surface Materials*
 - Preparation and testing of floor surfaces
 - Floor covering materials (FCM), floor treatment materials (FTM), walkway construction materials WCM
 - Average SCOF at least 0.50 and individual SCOF 0.45 (no mention wet or dry)
 - Uses the James Machine
 - Implies wet test is acceptable











U.S. Department of Labor
Occupational Safety and Health Administration
Washington, D.C. 20370
Reply to the attention of:

JUN 10 2008
DHEP/CRP/PIK-13042

Ms. Donna M. Garner, PhD
Vice President, Health and Safety
Regulatory Affairs
National Restaurant Association
1200 Pennsylvania Street, NW
Washington, DC 20036-3007

Dear Ms. Garner:

Thank you for your February 27 letter to the Occupational Safety and Health Administration's (OSHA) Directorate of Enforcement Programs (DEP). Your letter has been referred to DEP's Office of General Industry Enforcement (OGI) for an answer regarding OSHA's recent Personal Protective Equipment (PPE) payment standard, 29 CFR 1910.132(b). Your questions have been restated below.

Scenario: There is an array of shoe types worn throughout the restaurant industry. Employees are required to wear shoes that are uniform in color and offer slip resistant soles. The employees wear the shoes to and from work and in other places outside of the work environment. The shoes are what the restaurant considers a standard work shoe and are basically indistinguishable from ordinary street shoes.

Questions: Do employees have to pay for these types of non-slip shoes that offer some slip resistance but are basically standard work shoes?

Response: No, the employer is not required to pay for non-specially shoes that offer some slip resistant characteristics that are otherwise ordinary clothing in nature.

To view information on being updated on work developments, you can email OSHA's website at itp@www.osha.gov. If you have any further questions, please feel free to contact the Office of General Industry Enforcement at 202-269-1411.

Sincerely,
Richard B. Pevita, Director
Directorate of Enforcement Programs

- OSHA PPE payment ruling "specialty non-slip soles"

Slip-Resistant Footwear Policy

- Should be in writing
- Specify selection, purchase, reimbursement and replacement
- Specify purchase/reimbursement
 - Company purchase
 - Employee purchase
 - Payroll deduction plans



Fall Safety Management Process



Management responsibility

Warning signs & instructions

Education and training

Incident and injury surveillance

Hazard surveillance

Floor surface selection

Floor surface treatments

Housekeeping and maintenance

Slip-resistant footwear

Mats

Walkway slipperiness assessment

Slips, trips falls



Benefits of Mats

1. Prevent slips and falls
 - Absorb water/contaminants, remove soils
 - Provide slip-resistant surface
 - Elevate above standing water
2. Reduce floor maintenance
 - Keep floors clean
 - Reduce wear, protect finishes
3. Reduce standing fatigue



Entrance Mat Types

- Well and grate system
 - Funnels and drains moisture down and away from floors. Permanent fixture at entrances.
- Recessed
 - Permanent mat installed in a well or recessed surface flush with floor.
- Loose-Lay
 - Stays in place without adhesives.

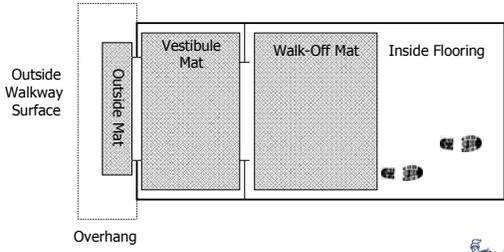


Entrance Mat Criteria

- Sufficient running length and width (unpublished manufacturer's study)
 - Snow: 10 - 12 walking steps
 - Rain: 8 - 10 walking steps
 - Dry: 6 - 8 walking steps
- 80% of soil entering a building can be trapped within the first 15' on a carpeted surface (ANSI A1264.2)
- Designed and placed so as not to create additional fall hazard
- Rule of thumb: should not be able to see footprints after stepping off mat (wet)



Mat Selection

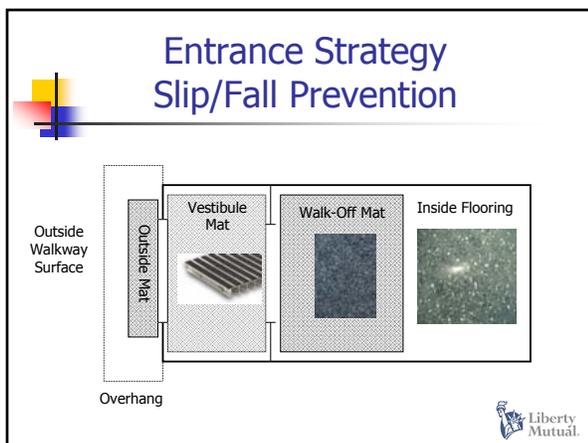




Entrance Risk Assessment

- ☑ Walkway surface material can be slippery when wet e.g. VCT, terrazzo, polished granite/marble, glazed smooth ceramic tiles etc. and,
- ☑ There are no interior mats or,
- ☑ There are mats but by design and installation they do not,
 - Adequately absorb moisture from footwear
 - Adequately remove soils from footwear
 - Perform well because they are dirty





Area Mats, Runners, Platforms

- Ice machines
- Sinks
- Coolers
- Kitchens
- Cafeterias
- Manufacturing Areas



Back Entrance LMRIS



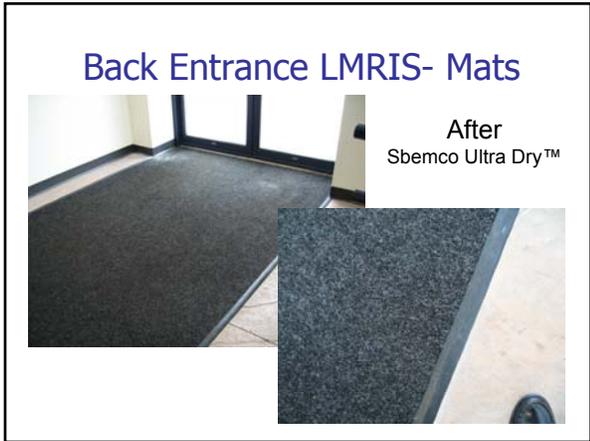
Back Entrance LMRIS- Mats

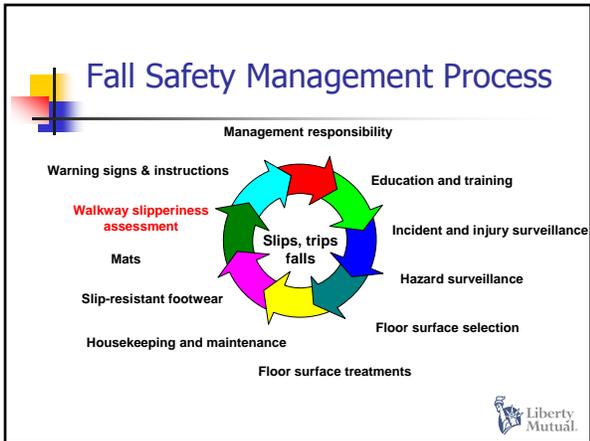
Before

- Mats Inc. Soft Grid™









Slipperiness Assessment

- 0.5 or higher considered "slip-resistant"
- Problem is:
 - Most dry surfaces are 0.5 or higher
 - Slips/falls occur when floor is wet and contaminated (dust, grease, oil etc.) or when transitions from "slippery" to "non-slippery" floors occur
 - Combination of all above when floor is worn



Slipmeters or Tribometers



Brungraber Mark II (PIAST)



English XL (VIT)



Horizontal Pull Slip Meter (HPS)
ASTM F609



Others



British Pendulum Tester



American Slip Meter

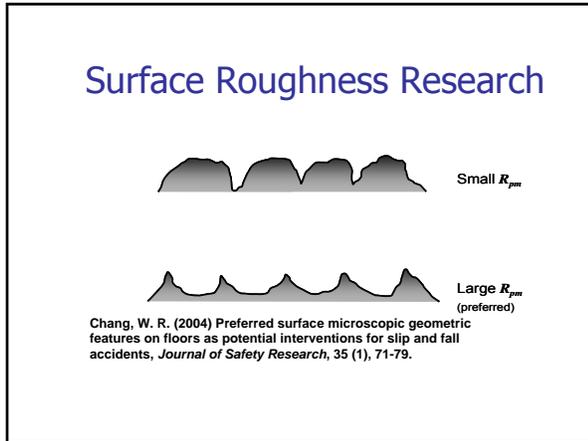


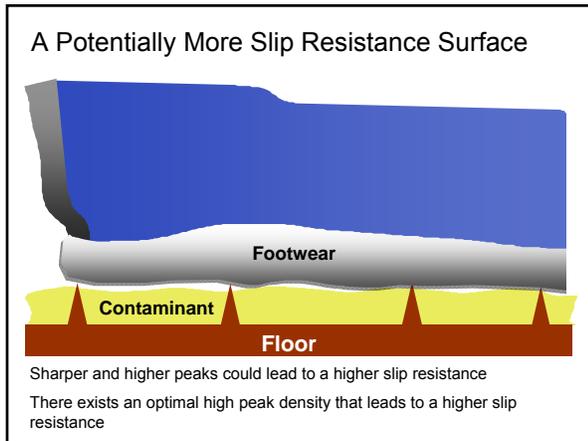
BOT-3000



Tortusil



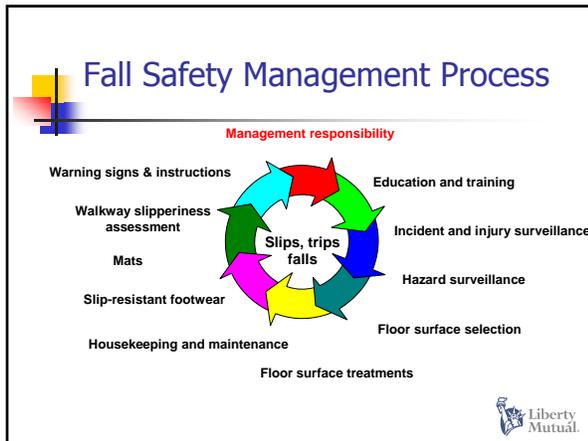




Evaluating Surface Roughness

- Rz scale (average peak-to-valley height)
 - Higher the number the more aggressive the surface roughness
 - Health and Safety Executive (HSE) Slip Assessment Tool (SAT) ranking (Rz)
 - ASTM F802 selection of walkway surface selection revision specifies 20 μm or 50 μm for wet surfaces
 - ASTM F13 workshop 6-20-07 correlation of friction and Rz slipperiness



- ### Management Responsibility
- Written program include:
 - Objectives (ID high risk jobs, affected EEs)
 - Tasks necessary to attain stated objectives
 - People responsible & oversight of program
 - Training for all members of organization
 - Necessary resources
 - Implementation schedule
 - Periodic evaluation
- Liberty Mutual

- ### Obstacles to Achieving Goals
- Unclear objectives
 - Too many objectives
 - Not tied well to results
 - Poorly communicated
 - Not understood
 - Limited buy-in
- Liberty Mutual

Example Goals and Objectives

- Reduce new slip and fall claims by 50%
 - Identify problem locations. Target date
 - ID specific causes of STF
 - Train local managers on cause and prevention of STF
 - Evaluate and improve housekeeping program
 - Develop walkway surface evaluation form. Target date
 - Enhance corporate due diligence checklist for new facilities to include slip and fall prevention. Target date
 - Train Design and Construction and Facilities on causes of STF and Facility design standards.



Who Needs Training?

- Corporate Real Estate/Facilities Management
- Corporate Risk Management & Safety
- Occupational Health
- Human Resources
- Managers and line supervisors
- Employees



Program Evaluation

- Periodically review program
- Is program achieving good outcomes?
 - If not why not?
- Make changes
- Remember, goal is continuous improvement





In Summary

- Preventing slips, trips and falls requires an integrated process involving all in the organization
- Have a plan; target problem locations, jobs, tasks etc.
- S & F program success = realistic objectives and measures.
- Employee participation key to success.





Questions?