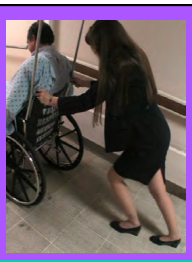

Floor Slip Resistance Requirements under 2012 International Building Code

Prepared for LACSI, March 25, 2015

J. George Sotter, P.E., Ph.D.
Sotter Engineering Corporation
Mission Viejo, CA

www.SafetyDirectAmerica.com
1-800-988-6721

Learning Objectives

- ✓ IBC 2012 requirement for slip resistance (ANSI A137.1)
- ✓ Changes that occurred in ANSI A137.1 in 2014: *minimum* wet DCOF
- ✓ Slip resistance testing in lab or on-site for compliance
- ✓ How to specify and buy *safe* flooring
- ✓ Remediation of slippery floors
- ✓ Using flooring that doesn't meet the code requirement

Owner's Objectives

Prevent PAIN, SUFFERING and FINANCIAL LO$$ES caused by slip-related falls and ergonomic injuries

Protect all from unjustified or fraudulent LAWSUITS

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Previous Situation

- Static coefficient of friction (SCOF) of 0.60 for level floors was not useful and is now abandoned
- Static friction applies to people standing still
- ADA's Access Board does not recommend using SCOF, and never did

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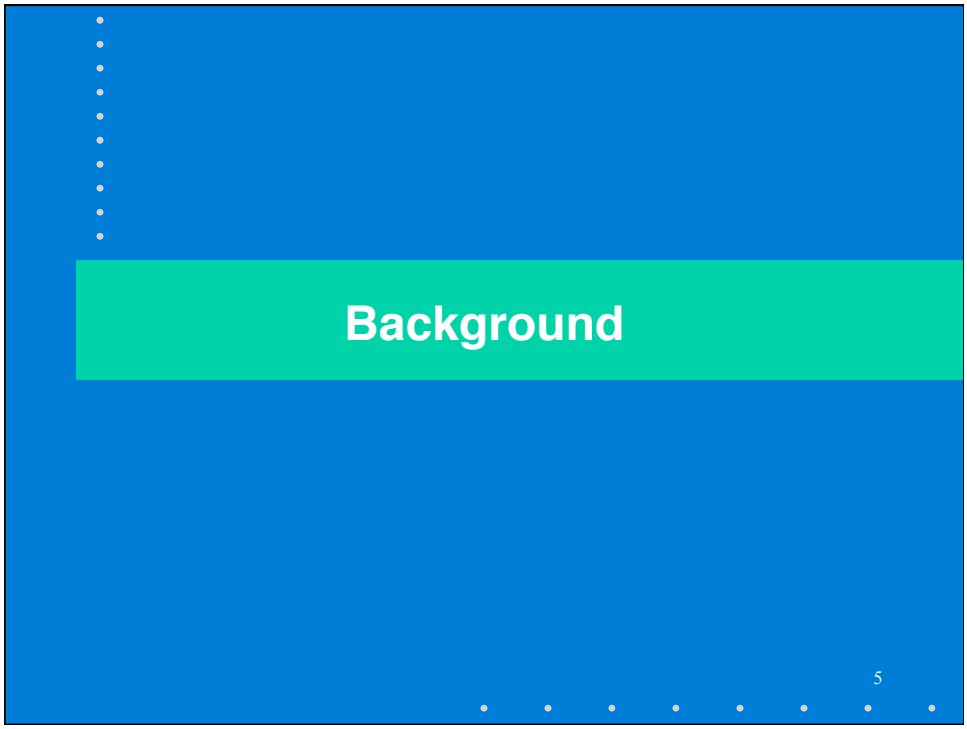
Background
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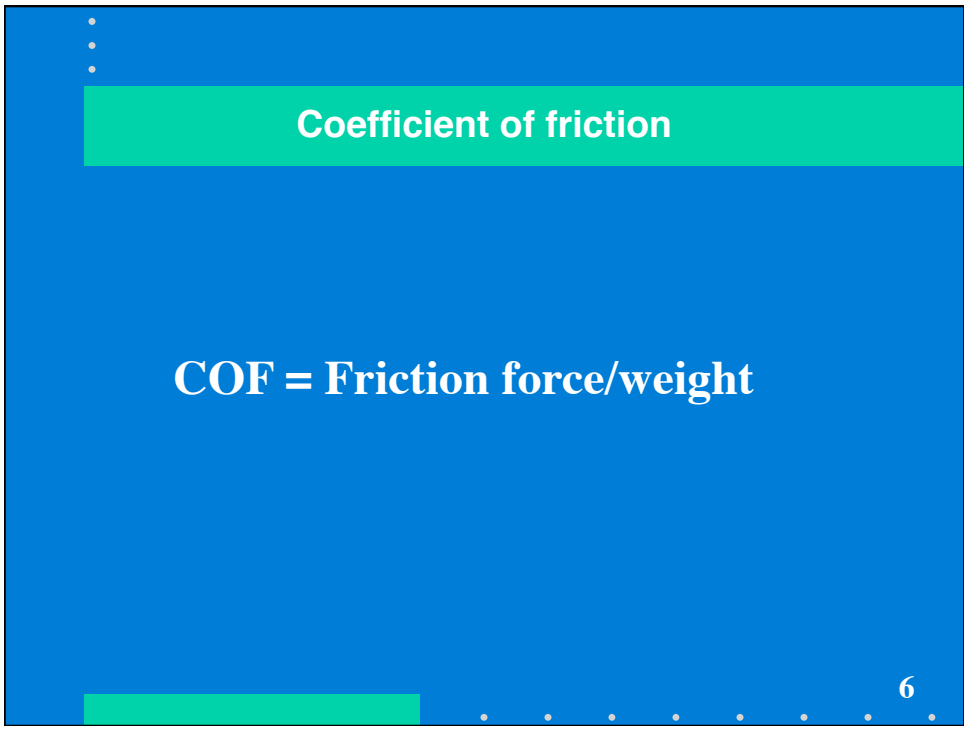
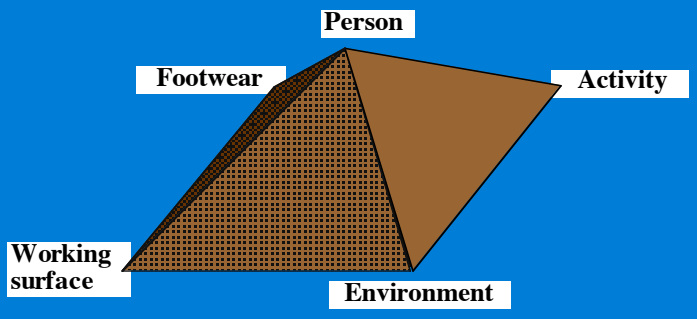

Coefficient of friction
COF = Friction force/weight
6

Ingredients of a slipping incident



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Causal factors: Person

- Prescription and other drugs or alcohol
- Drug adverse interactions

- Health factors
  - ✔Osteoporosis (especially women over age 50)
  - ✔Diabetes (neuropathy)
  - ✔Seizures, drop attacks, stroke, arthritis, etc.

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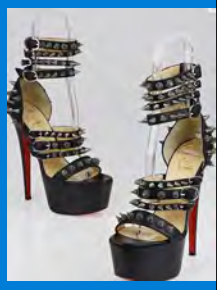
Causal factors: Footwear

- Leather or plastic solings and hard heels are slippery on many dry surfaces
- Soft rubber can give good *wet* traction when it has well-designed tread, but can be treacherous when tread has worn off!
- Bare feet have no tread and can be slippery on a wet floor



Christian Laboutin $1995.00

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Slip Resistance of Footwear

There are NO SAFETY STANDARDS for footwear slip resistance in the USA and most other countries

After an accident, testing of the footwear may determine that it, not the floor, was the cause of a slip

Even expensive shoes (over $3000) are often unsafe

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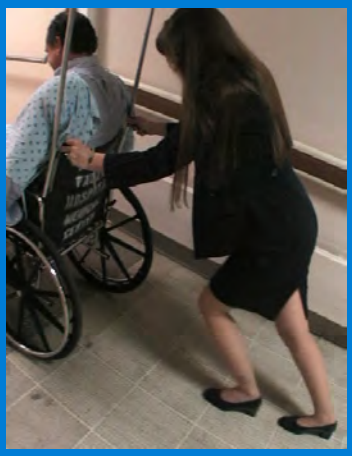
Causal factors: Activity

- Traction requirements *depend on the activity*
- Rushing, especially in turns or on stairs, requires more traction than strolling
- Pushing (wheelchair, food cart, mop), pulling require extra traction *without help from extra weight on shoes*



Causal factors: Environment

- Lubricants
  - ✔Rainwater
  - ✔Detergent residue
  - ✔Beverages
  - ✔Furniture polish, WD-40, perfume
  - ✔Debris, including food, sauces, dust
- Distractions and lighting
  - ✔Glare
  - ✔Poor lighting conceals hazards

Some Key Areas that Need Wet Slip Resistance

- Spa shower-Jacuzzi areas
- Bathroom floors
- Bathtubs
- Dining areas, self-serve
- Kitchens
- Pool decks and stairs
- Outdoor walkways
- Showers

13

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Code Requirements

14

2012 IBC

2103.6 Ceramic tile. Ceramic tile shall be as defined in, and shall conform to the requirements of, ANSI A137.1.

ANSI A137.1, Coefficient of Friction Section

"(DCOF) does not predict the likelihood a person will or will not slip on a tile surface ...

"... tiles suitable for level interior spaces expected to be walked upon when wet shall have a wet DCOF of 0.42 or greater when tested using SLS (wetting agent) solution as per [BOT-3000E tribometer procedure]."

Underside of BOT-3000E

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ANSI A137.1 relevant section: excerpt

"Tiles with a DCOF of 0.42 or greater are not necessarily suitable for all projects. The specifier shall determine tiles appropriate for specific project conditions, considering by way of example, *but not in limitation,*

"type of use,

traffic,

expected contaminants,

expected maintenance,

expected wear, and

manufacturers' guidelines and recommendations."

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18

Tile Council's Additions

TILE COUNCIL OF NORTH AMERICA, which wrote the ANSI A137.1 slip resistance section, states that the possibility of a slip may also be affected by

- **The material of the shoe sole and its degree of wear**
- **The speed and length of stride at the time of a slip**
- **The physical and mental condition of the individual at the time of a slip**
- **Whether the floor is flat or inclined**
- **How the surface is used**
- **How the tile is structured**
- **How drainage takes place if liquids are involved**

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THE Key Word in Lawsuits

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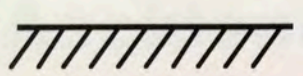
The Bottom Line

ANSI A137.1 sets a low bar: a minimum (0.42) that most tiles exceed ex factory

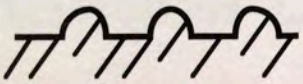
It does not ensure safety. That's your job.

Making it Work

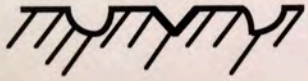
What makes wet slip resistance



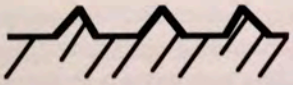
Flat: slippery when wet or otherwise lubricated



Bumps: may be of little traction benefit



Suction cups: improved traction when kept clean



Teeth: improved traction wet or otherwise lubricated. More energy needed to clean than if flat

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Four Extreme Examples

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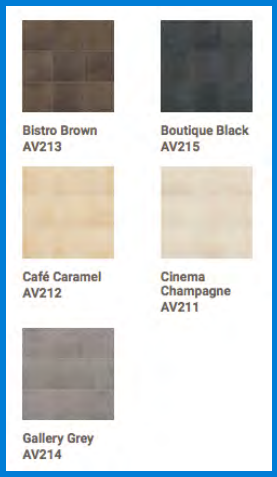
Where can you find DCOF data?

- Crossville's web site shows DCOF for all their floor products; ranges as high as 0.66–0.76 for "Main Street" tile (five colors at right)
- Others may supply current data on request, but no guarantees
- Agrob Buchtal has long experience with anti-slip tiles
- For planning your long-term projects, data might not be offered because production variables can change



Fitting Slip Resistance to the Situation

- USA offers no standards to account for the many variables that ANSI says must be considered: type of use, traffic, expected contaminants, etc., etc., etc.
- Standards Australia has such standards; in effect since 1999 and fine-tuned in 2014; over 30 situations are covered
- The Aussie standards use pendulum test data, the standard in 49 nations on six continents and in continuous use since 1970
- We believe that using A137.1 PLUS Aussie standards means due diligence, best possible practice, and all that is reasonably practicable

Pendulum in Action




27

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Minimum Pendulum Values Recommended for New Flooring

	Minimum Wet Pendulum Test Value PTV, Hard rubber slider	Soft rubber
■ Dry areas, incl. supermarket aisles	12	--
■ Hospital or aged care bathroom	35	35
■ Pool deck	45	40
■ External walkway, slope <1:14	45	40
■ External ramp slope > 1:14	55	45
■ Pool stairs or ramps into water	55	45
■ Commercial kitchen	55	45
■ Basketball court	--	80 (dry)

for more see http://safetydirectamerica.com/improving-the-worlds-most-sophisticated-floor-slip-resistance-testing-standards/

28

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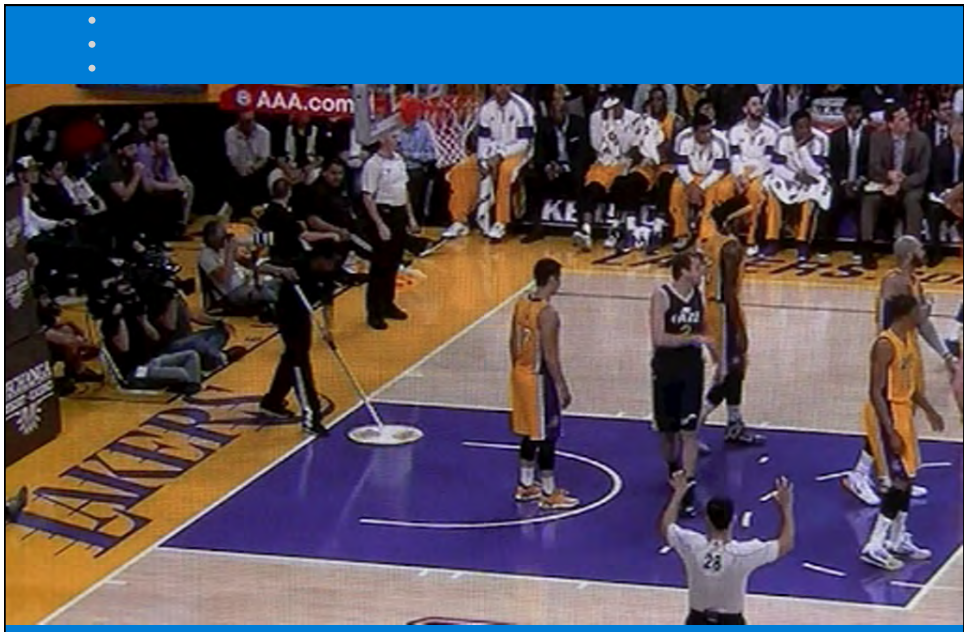

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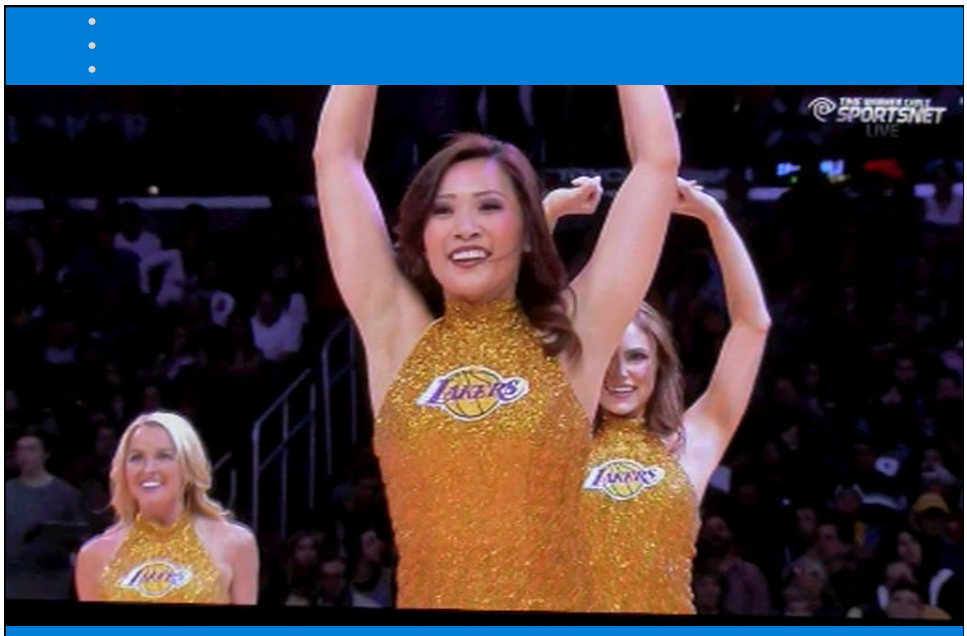
29



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DIN 51097 for Barefoot Flooring

Two walkers test barefoot wet

Categories A, B, C (C has highest slip resistance)

A: Locker rooms

B: Pool decks

C: Stairs leading into water

31

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Cost of Testing

- Lab tests:
  - ✔$161 – $368 depending on type and number of tests; 3-day turnaround
- Field tests: $98/hour plus expenses
- *When to test?*

32

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Quality Assurance: When to test wet DCOF

Sequence	Event	Example of potential problem	Where test is conducted	Who is protected by the test [who pays for it]
1	Purchase order	Slip resistance not as advertised	Laboratory	Architect
2	Delivery	Product as delivered not to spec	Laboratory	General contractor
3	Post-installation	Slip resistance affected by sealer, grout deposits on surface or inappropriate choice of flooring for use of area (shower, pool, entrance lobby, etc.)	In situ	Installer
4	Handover	Slip resistance destroyed by construction cleanup or by deposits left by constructors	In situ	Building owner

Maintaining Good Wet Slip Resistance

- Flooring that is slip-resistant when wet takes more energy to clean than slippery flooring
- Sometimes abrasive pads are used for cleaning, even immediately after installation; risky practice
- Some flooring can lose its good wet slip resistance before it has been *used for one day*
- What's needed is *sustainable slip resistance* under real-world conditions

Some Companies Implementing Sustainable Slip Resistance

- McDonalds
- Toyota
- Westfield
- Aldi Supermarkets
- Stockland
- Carnival Cruise Lines
- Royal Caribbean

35

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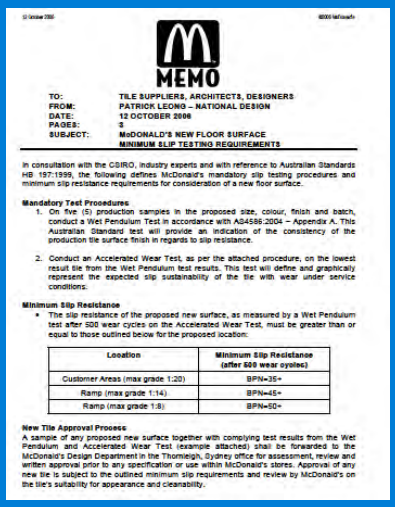
McDonalds SSR Spec



MEMO

TO: TILE SUPPLIERS, ARCHITECTS, DESIGNERS
FROM: PATRICK LEONG – NATIONAL DESIGN
DATE: 12 OCTOBER 2006
PAGES: 3
SUBJECT: McDONALD'S NEW FLOOR SURFACE MINIMUM SLIP TESTING REQUIREMENTS

In consultation with the CSIRO, industry experts and with reference to Australian Standards HB 197:1999, the following defines McDonald's mandatory slip testing procedures and minimum slip resistance requirements for consideration of a new floor surface.

Mandatory Test Procedures

1. On five (5) production samples in the proposed size, colour, finish and batch, conduct a Wet Pendulum Test in accordance with AS4586:2004 – Appendix A. This Australian Standard test will provide an indication of the consistency of the production tile surface finish in regards to slip resistance.
2. Conduct an Accelerated Wear Test, as per the attached procedure, on the lowest result tile from the Wet Pendulum test results. This test will define and graphically represent the expected slip sustainability of the tile with wear under service conditions.

Minimum Slip Resistance

- The slip resistance of the proposed new surface, as measured by a Wet Pendulum test after 500 wear cycles on the Accelerated Wear Test, must be greater than or equal to those outlined below for the proposed location:

Location	Minimum Slip Resistance (after 500 wear cycles)
Customer Areas (max grade 1:20)	BPN=35+
Ramp (max grade 1:14)	BPN=45+
Ramp (max grade 1:8)	BPN=50+

New Tile Approval Process

A sample of any proposed new surface together with complying test results from the Wet Pendulum and Accelerated Wear Test (example attached) shall be forwarded to the McDonald's Design Department in the Thornleigh, Sydney office for assessment, review and written approval prior to any specification or use within McDonald's stores. Approval of any new tile is subject to the outlined minimum slip requirements and review by McDonald's on the tile's suitability for appearance and cleanability.

36

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Sustainable Slip Resistance (SSR) Test

- Test with pendulum
- Abrade wet for at least 500 cycles with 3M green pad loaded with 1 kg
- Test again with pendulum
- Cost: $290 per sample including wet PTV before and after abrasion

- McDonalds spec for customer areas: PTV of 35 or higher after abrasion

Using "Slippery When Wet" Flooring

- Smooth, glossy flooring is generally slippery when wet, regardless of ANSI A137.1 test result
- Such flooring can be safe if it's kept dry
- Even if safe, a floor can draw slip-and-fall lawsuits due to other factors (footwear, substance abuse, fraud, etc.)

Keeping Slippery Floors Dry

1. Overhang outside
2. Mats — at least 12 feet. Velvet ropes if needed
3. Umbrella bag stand
4. Dust-mopping
5. Documented surveillance for spills, etc.

39

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Outdoor Surfaces

- Not covered in ANSI A137.1 or any U.S. standard
- Posting hazard warnings is no substitute for safe design
- BOT-3000E is low-speed and not appropriate for where people may be running
- We recommend pendulum tests for outdoor surfaces and for pool decks; endorsed by Ceramic Tile Institute of America since 2001

40

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Benefits of DCOF monitoring

- Periodic dry and/or wet testing after installation confirms floor has maintained good slip resistance
- Testing before and after an accident documents that property owner exercised *due diligence, best possible practice, and all that is reasonably practicable*
- Testing of footwear from an accident may indicate that it was the cause of the slip
- Can reduce payouts by up to 98 percent in large properties

Benefits of Floor Monitoring to Owner

- Confirm that floor surfaces are compliant
- Document due diligence, best possible practice, and all that is reasonably practicable
- Protection from creative expert witnesses
- Protection from fraudulent claims
- Avoid liability for problems caused by others (unsafe footwear, intoxication, etc.)

Recap

- 2012 IBC requires *minimum* DCOF of 0.42 for ceramic tile in level areas that may get wet
- Testing in lab or on-site uses BOT-3000E digital tribometer
- *Safety* may require DCOF *much higher than 0.42*; pendulum test standards can provide reasonable criteria as Pendulum Test Values of 12–55 or higher
- Strategic testing can prevent costly problems
- Chemical treatments, transparent abrasive coatings, and abrasive paints and tapes can remediate slippery floors
- Flooring that's slippery wet can be fine if it's kept dry