Slip resistance according to Goldilocks

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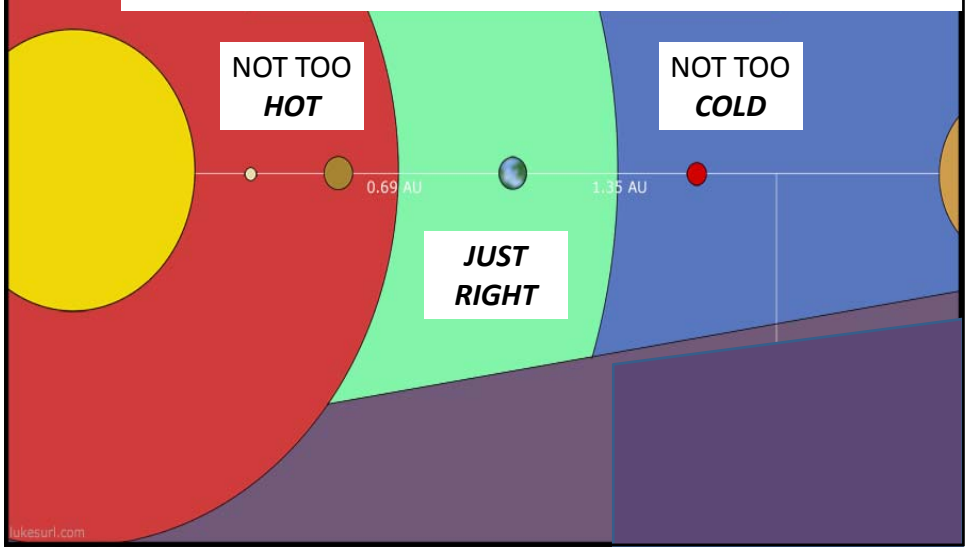
universal design CONFERENCE

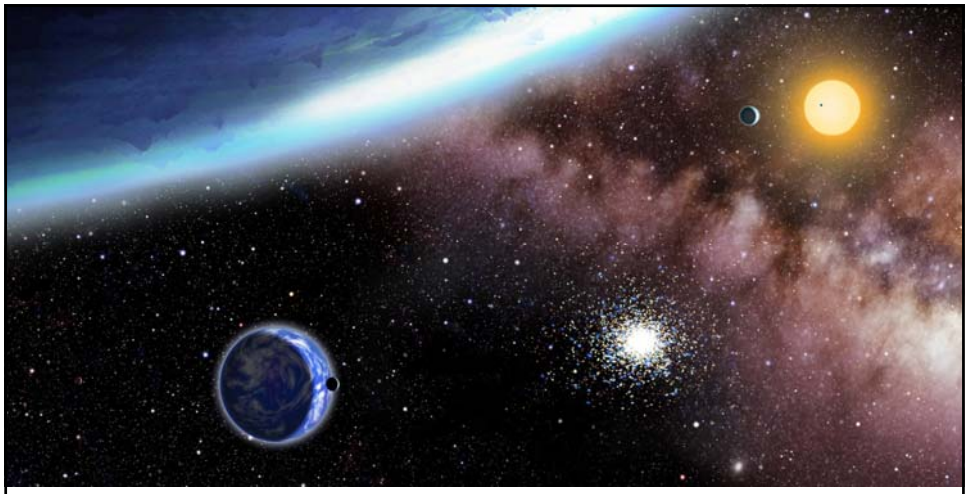
We don't see things as they are,
we see them as we are.
-- Anaïs Nin

ASTROBIOLOGY 101

To potentially support life a planet needs to be in the

"GOLDILOCKS ZONE"





Slip resistance

Getting it **just right**

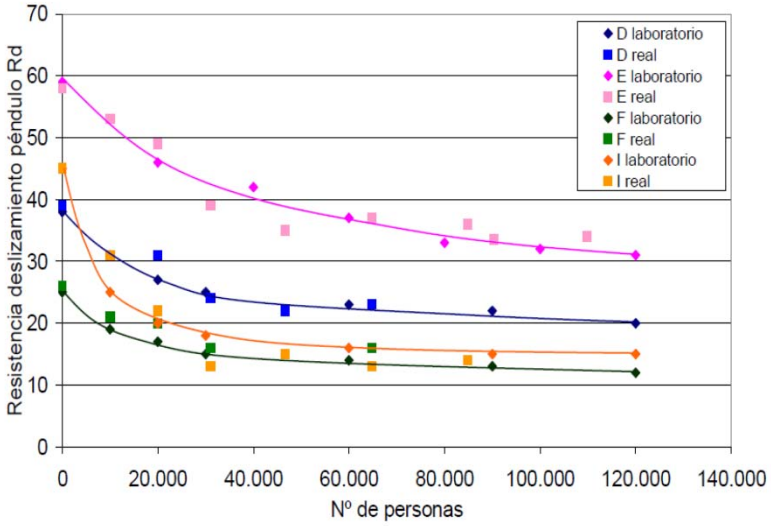
An alien perspective

Getting it just right . . .

- . . . requires sustainable slip resistance
- . . . means taking more than a tick ‘n flick approach to planning and design
- . . . requires more understanding of the product; and how to optimise its life cycle aesthetic and functional performance
- . . . implies a low cost, **environmentally friendly** maintenance program
- . . . is difficult, if not impossible, if you only determine ex factory slip resistance

Architecture is more than getting great photos at handover

An inconvenient truth



Accelerated Wear Test Method

- Investigation of effects of abrasive materials
- Initial trials used by hand

- Gardco 12VFI linear motion washability machine
- Traditionally used for wear resistance of paint
- 100mm x 100mm friction boat
- Operates 50 cycles per minute over 300mm length
- Can be used onsite
- Initially used 1 tile for testing
- **Now test 5 tiles to assess variability**

SafeEnvironments
MANAGING PROPERTY RISK

www.SafeEnvironments.com.au

The Hexapod

Perfect for accelerated conditioning of resilient flooring

ASTM D5252 should be adopted in our slip resistance Standards to change the basis of specifications.

R. Kuisma et al. / Wear 258 (2005) 826–834

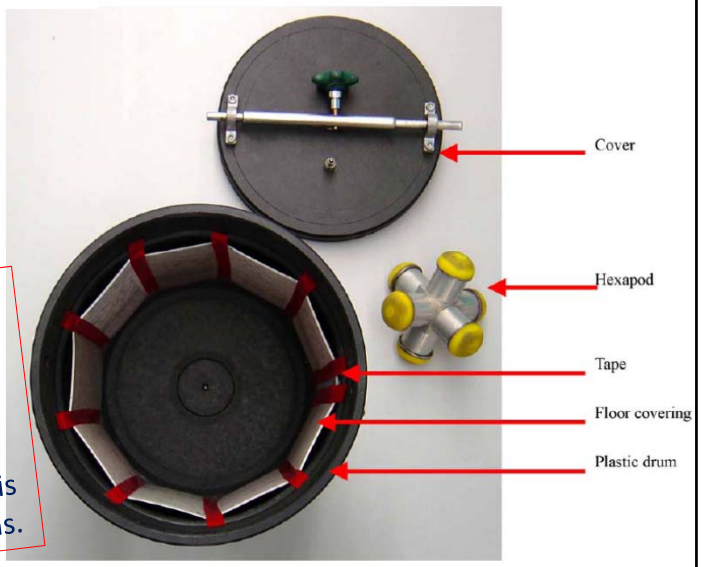


Fig. 1. The soiling and wearing drum.

HB 198 guidance Table 3B

Hotels, offices, public buildings, schools	Pendulum	Platform
Entries , common areas, lift lobbies		
Wet areas	P3	R10
Transitional areas	P2	R9
Dry areas	P1*	R9
Toilet facilities	P3	R10
Hotel apartment bathrooms	P2	A
Hotel apartment kitchens & laundries	P2	R9

* The minimum classifications listed in Table 3B are P1 and R9. It is inappropriate for Table 3B to list the lower classification P0, since there is no lower limit on classification P0.

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No domestic residential guidance

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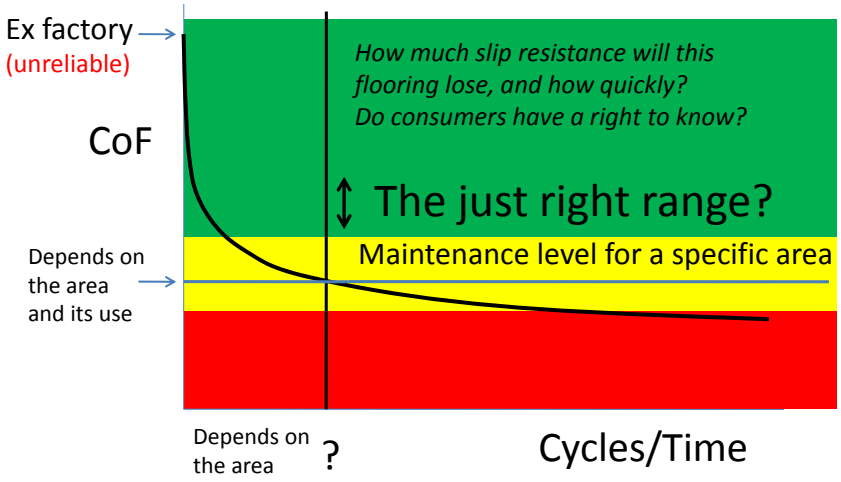
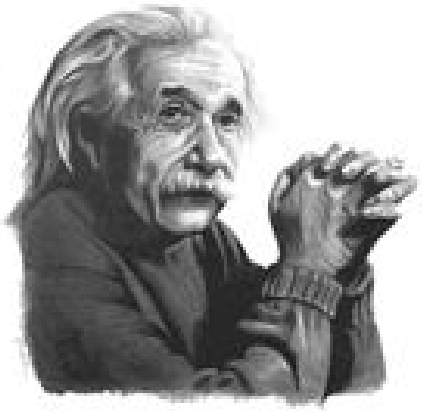
Establishing new criteria

is not difficult to do





"Insanity:
doing the same thing
over and over again
and expecting
different results."
Albert Einstein

We need to specify slip resistance differently, whereby property owners and managers can have a basis for determining whether their floors are sufficiently safe.

Livable Housing Australia – Guidelines for Bathrooms

The following is in response to the LHA's request for comments on the draft publication – Livable Housing Design Guidelines for Bathrooms.

Within that guideline we note LHA is looking to specify the following –

'All bathroom flooring meets or exceeds class X.'

Upward quality spirals should commence with sensible entry level requirements

Livable Housing Design
Registered Assessor Handbook

June 2014

4.4. Slip Resistance

Whilst there are tools available for measuring slip resistance, there are no standards with which to interpret the results. As a consequence assessment of slip resistance will rely upon professional judgment of Registered Assessors. Should an assessor want to use a slip resistance meter, they can be hired from Tech Rentals.

www.techrentals.com.au

Correction overdue

Livable Housing Design
Registered Assessor Guidance Notes
Issue 3: May 2014

Livable
Housing Design

Correction overdue

Q2. How is slip resistance determined?

A2. Slip Resistance is referenced in the National Construction Code and ultimately, Livable Housing Australia would like to defer to the NCC and the Australian Building Codes Board (ABCB) for rulings related to slip resistance. Standards Australia publish a number of standards as well as a handbook that address slip resistance of surfaces.

Table 3 of *HB197 – An Introductory Guide to the Slip Resistance of Pedestrian Surface Materials* provides the most appropriate reference for the performance requirements of different surfaces. This table nominates the performance requirements for different test methods and should be referenced for the minimum requirements for the Livable Housing Design Guidelines.

Registered Assessors should note the limitations of slip resistance test methods and the inherent inaccuracies of specific testing. HB197 provides specific guidance related to this.

and the Technical Advisory Panel meets 4 times each year?

Floors should be . . .

- **Not too slip resistant when new** (so as to prove difficult to clean)
- **Sufficiently slip resistant at the end of their working life**

How much traction is required?

- If a floor surface has greater available traction than a pedestrian demands, it should be safe
- However, we determine human traction demands on force plates in laboratories; and measure the availability of flooring traction using competing test methods

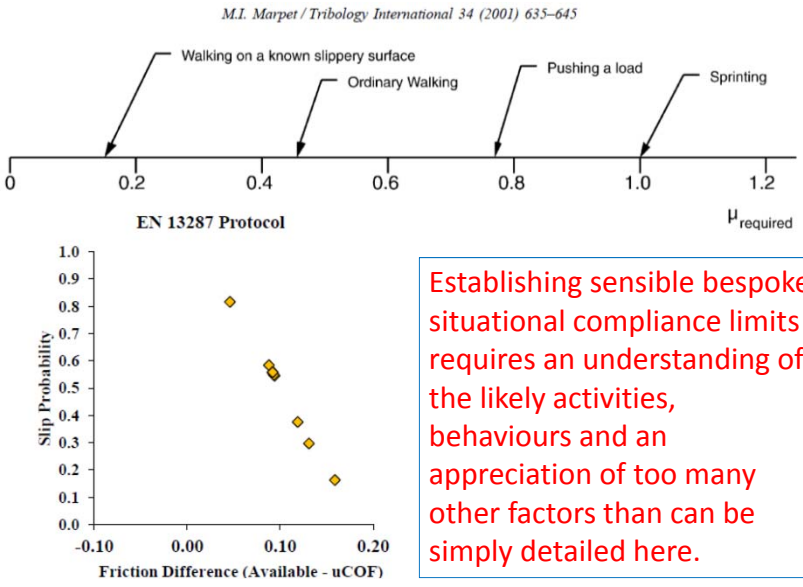
People have different traction demands

From Burnfield & Powers, 2003

		SLOW		MEDIUM		FAST	
		Mean (SD)	Range	Mean (SD)	Range	Mean (SD)	Range
Young	Females	.24 (.05)	.20 - .35	.24 (.02)	.21 - .28	.25 (.04)	.21 - .32
	Males	.19 (.04)	.14 - .30	.21 (.02)	.18 - .24	.27 (.03)	.23 - .31
Middle	Females	.24 (.04)	.16 - .28	.27 (.02)	.23 - .31	.26 (.05)	.18 - .34
	Males	.22 (.05)	.17 - .33	.26 (.06)	.20 - .39	.32 (.09)	.22 - .44
Senior	Females	.23 (.04)	.14 - .30	.22 (.03)	.18 - .26	.22 (.06)	.13 - .30
	Males	.19 (.02)	.17 - .22	.22 (.04)	.17 - .36	.24 (.06)	.17 - .37
Totals by Gender	30 Fem	.24 (.04)	.14 - .35	.24 (.03)	.18 - .31	.24 (.05)	.13 - .34
	30 Males	.20 (.04)	.14 - .33	.23 (.05)	.17 - .39	.28 (.07)	.17 - .44
Overall Total	All 60 subjects	.22 (.04)	.14 - .35	.24 (.04)	.17 - .39	.26 (.06)	.13 - .44

Table 1 – Peak COF_U values generated during walking at slow, medium and fast speeds, where each group consisted of 10 healthy subjects

Single requirement abstraction nonsense



Establishing sensible bespoke situational compliance limits requires an understanding of the likely activities, behaviours and an appreciation of too many other factors than can be simply detailed here.

Required Friction & Relative Risk

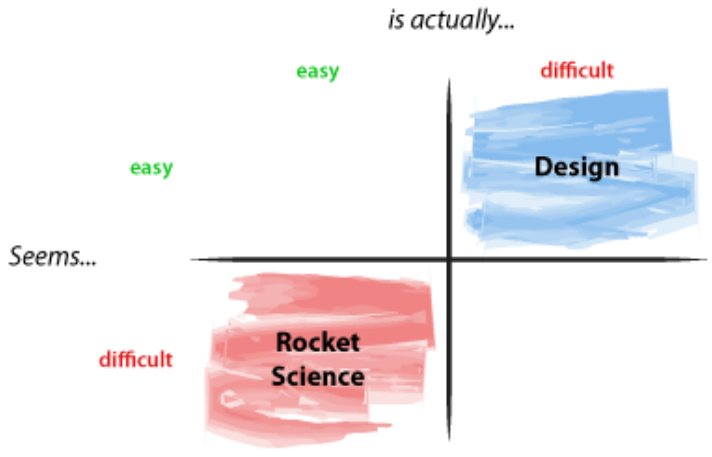
Research conducted by Harper, Warlow & Clarke (1961) & Pye (2001), BRE, UK

Most people require between 0.16 and 0.22 Coefficient of Friction for level walking

N = 124, (M 87, F 37) Mean CoF_u 0.17 for men; 0.16 for women

Risk	Straight walking	Turning: left foot	Turning: right foot
1 in 1,000,000	0.36	0.40	0.36
1 in 100,000	0.34	0.38	0.34
1 in 10,000	0.29	0.34	0.33
1 in 200	0.27	0.31	0.32
1 in 20	0.24	0.27	0.29
1 in 2	0.19	according to HSL (UK)	

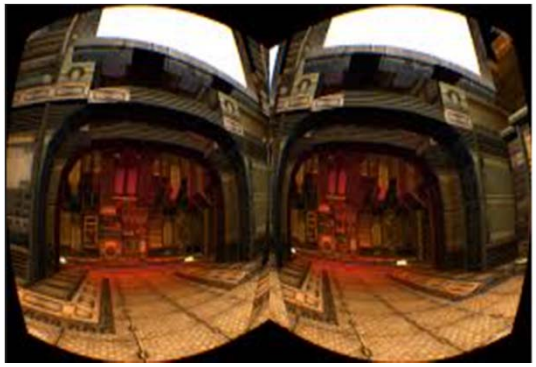
. . but what is adequately slip resistant?

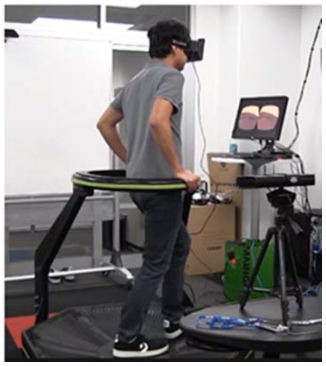


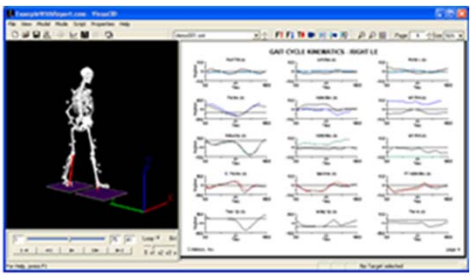
"Rocket science is much easier than good design".

We have no benchmarking data??

Using Virtual Reality Environments in Gait Biomechanics Experiments to Determine the Required Slip Resistance of Flooring Materials







Please be inclusive:
Contact me afterwards?

This world leading research should ultimately lead to bespoke slip resistance design applications and an ability to assess the comparative effectiveness of potential physical & aesthetic design solutions.

It would be foolish to depend solely upon the goodwill and generosity of a few concerned individuals to meet future funding needs.

The BCA and falls prevention: based on facts or clichés & innuendo?

- ABCB commissioned MUARC 281 (2008): *"The relationship between trips, slips and falls and the design and construction of buildings"*
- **There was no quantification of slip resistance; no relationship between slip occurrence and the magnitude of slip resistance; and there is no benchmarking of the level of slip resistance.**
- **Please** show us the data that has informed slip resistance requirements and recommendations?

Hazard 59, 2005 (MUARC)

Gunatilaka, Clapperton & Cassell

Falls in the home:

- 1/5 of unintentional injury deaths
- 2/3 home injury admissions
- 1/3 home injury Emergency Department presentations

- Research: structural slip and trip hazards (found in 19% of older (> 60 years) residents' homes:
  - Shower bases; defective floor finishes; dangerous staircases, obstacles like protruding door thresholds

(Archicentre , 2002)

However, were the architects competent to determine slippery surfaces (that were not mentioned)?

Archicentre/VIC Dept Human Services

In pursuit of health and independence: A housing profile of Victoria's older population (2002)

- The free inspections were made by architects. About one-third of inspections were booked by **occupational therapists**.
- 11,624 metropolitan Melbourne, 2771 rural Victoria inspections during 1998 to 2002.
- About 25% of homes built before World War II.
- 83% of homes had timber sub-floors.

Archicentre 2002 Trip & Slip Findings

- The most common trip and slip hazards were obstacles like protruding door thresholds, shower bases, defective floor finishes and dangerous staircases. Loose rugs and power cords were other potential hazards.
- What this seems to say is that households with less money, spend less on regular maintenance. This can lead to a higher rate of falls.

Slippery floors were not specifically identified or discussed as a hazardous item.

Archicentre's Tips on Fall Prevention

- A flat, accessible site is ideal for older residents who gradually lose mobility or balance and risk injury, whilst attempting to negotiate uneven paving or steps.
- Weather protection between the garage and house will help reduce risks, such as carrying groceries in the rain over wet, **slippery surfaces.**
- Interior colour schemes with a good contrast helps people with diminishing eyesight identify doors, entranceways, and changed surface conditions.
- Installing extra power points eliminates the tangle of loose extension leads that can cause unexpected falls.
- Impact-absorbent floor surfaces to reduce potential fall injuries.
- Level entry showers.
- Grab rails in the bathroom for shower and toilet, & at front and rear steps.
- Replacement of worn, torn or loose floor coverings.
- Reflective or brightly coloured strips on stairs.
- Sensor lights to external areas.
  - **No mention of need for slip resistant internal finishes**

http://www.archicentre.com.au/media-releases/598--free-safety-checks-for-elderly-helps-cut-injuries

Were the architects suitably trained to make slip resistance assessments?

- General building inspections do not include slip resistance assessments. What training, qualifications and experience do architects have in slip testing?
- While the quality of architectural training is not questioned, are slip resistance outcomes dependent on daily footwear choice?
- Are architects' slip assessments repeatable or reproducible?

2014 Psychophysical Slip Testing Project

AIM: To compare human perceptions of slipperiness and the prospective risk of slipping in a residential bathroom with the results from different wet slip resistance test methods.

METHOD: Obtaining slip rankings based on:

1. Handling 12 dry flooring specimens
2. Handling the wet specimens
3. Walking in their shoes on wet specimens
4. Walking barefoot on wet specimens

Acknowledgments: Intertile Research, ATC NSW, TAFE NSW, Safe Environments, Test Slip Australia

Ranking system

With respect to the slipperiness of the material, is it:

1. Not at all slippery
2. Slightly slippery
3. Quite slippery
4. Extremely slippery

Preliminary findings

Pending further laboratory testing

- 77 subjects, varying levels of participation
- Inconclusive segmentation; personal bias
- 23 designers, 22 tiling industry
- 25 wet barefoot walkers
- Designers amazed by dry touch deceptiveness
- Glass mosaic best wet barefoot performance, very poor shod ranking
- Shod ratings probably reflect footwear

Mean rankings vs wet pendulum

Specimen	SRV	Class	Dry fingers	Wet fingers	Shod	Barefoot
A Ceramic tile	43	P3	2.09	2.54	2.26	2.29
B Ceramic tile	35	P3	1.81	2.28	2.01	2.47
C Ceramic tile	32	P2	2.12	2.15	1.92	2.38
D Ceramic tile	29	P2	1.74	2.84	3.14	3.04
E Honed tile	28	P2	3.23	3.06	2.53	2.60
F Vinyl, **RSC**	21	P1	2.60	2.45	2.34	2.59
G Honed marble	18	P1	2.38	2.97	3.65	3.20
H Glass **mosaic**	13 (20)	P1	2.38	2.73	3.80	1.93
I *Textured* tile	16	P1	1.97	3.33	3.51	3.40
J Pol porcelain, **RSB**	13	P1	2.79	3.53	3.66	3.66
K Glazed tile	9	P0	3.36	3.47	3.61	3.69
L Pol. Granite, **RSA**	8	P0	3.41	3.79	3.83	3.73

- Is X (P3) an appropriate recommendation for LHA bathrooms when the best performing wet barefoot product was the P1 glass mosaic?
- The P3 products were considered more slippery than some P2 products
- Would some of the (better performing) P2 products have previously been class X?

Interior decorators and architects

- Performed similarly to rest of subjects
- Realised that the traditional assessment of 100 x 100 mm samples is unreliable
- Many volunteered that they needed to change their product selection practices

All subjects (including access auditors, architects, OTs and pendulum operators) are poorly qualified to make subjective slip assessments.

Access auditors should …
Use the standard pendulum …

or rapidly obtain reproducible, compatible SlipAlert results

SlipAlert

•A practical rugged device that is quick and simple to use.
•It operates on the same energy loss principle as the pendulum and gives comparable results.
•It can be used between official audits to monitor the cleaning of floors, as well as at the time of accidents.

Further thoughts

- **MUARC 281**, the ABCB base document, is **fundamentally flawed** with respect to slip resistance: **it contains no objective slip data**.
- Has ABCB been impatient in its initial quantification of slip resistance requirements in the BCA?
- What are the broader implications of this?

Are the P classifications reliable?

- Were the V, W, X, Y, Z classifications reliable?
- The jury should always await outcomes
- However, there is always a dearth of publicly accessible evidence
- The P classifications are artificial constructs. Were the breaks appropriately selected?
- Should P0/P1 be at 15 rather than 12 SRV?
- There should be a P0 class for slider 55

NCC 2014 residential requirements

For stair treads, nosing strips, landings:

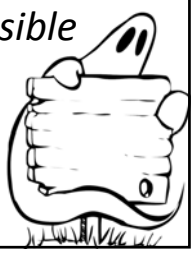
- Dry P3
- Wet P4

Some State implementation delays

This decision was based on the onerous 1999 (HB 197) recommendations for accessible internal **commercial/industrial** stair nosings

Perhaps NCC 2016 will quantify the accessible (AS 1428.1) slip resistance requirements?

If so, hopefully more sensibly.



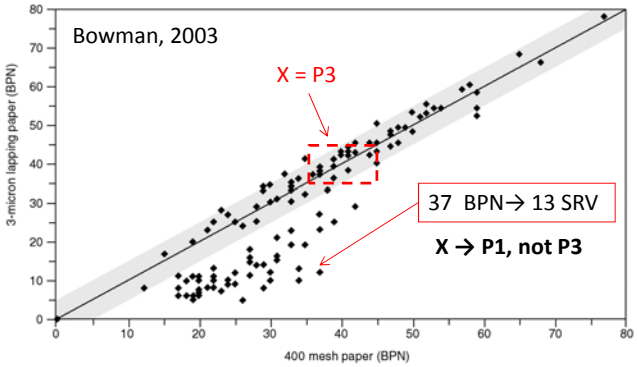
AS 4586:2013 vs AS/NZS 4586:2004

FALSE Notes in NCC 2014, HB 198:2014 and draft NCC 2015:

- For the purposes of assessing compliance, the slip-resistance classifications of V, W and X in reports based on the 2004 edition of AS/NZS 4586 may be considered to be equivalent to slip resistance classifications of P5, P4 and P3 respectively in the 2013 edition of AS 4586.
- **X = P3, or P2, and even P1**

Using lapping film to prepare rubber sliders gives lower results on smooth surfaces.

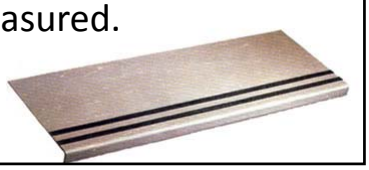
Old standard
400P paper
↓
Lapping film
New standard



This improves differentiation between marginal products: shouldn't such (artificially) reduced results cause some adjustment of the old safety limits?

A better step??

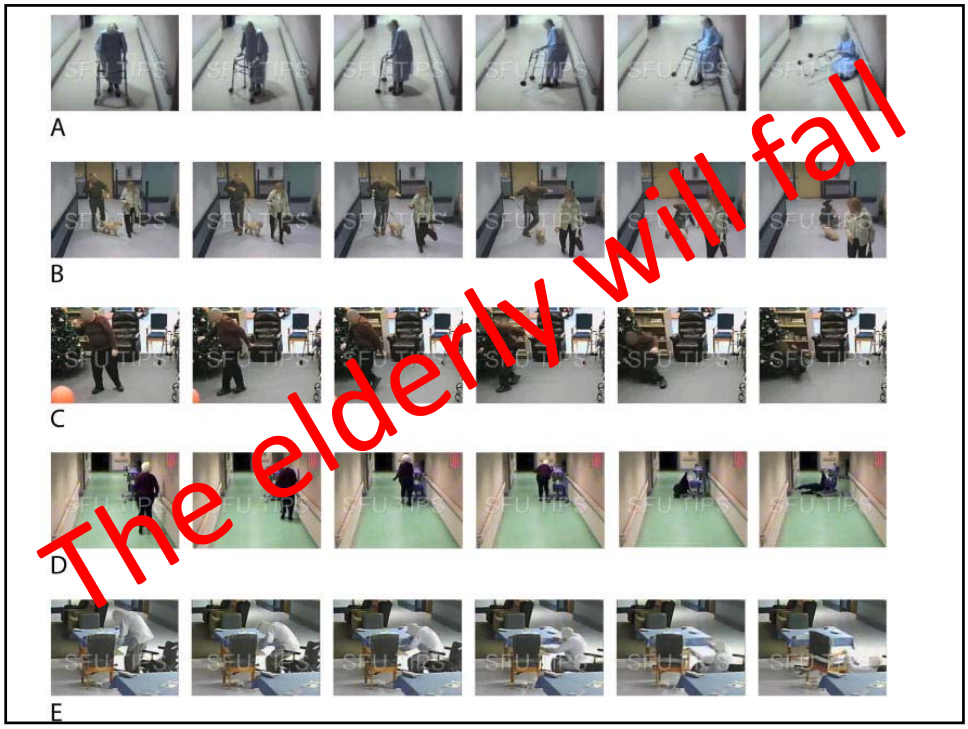
- MUARC 281 recommended minimum goings of 280 mm. The NCC 2012 proposal for 280 mm residential goings was dismissed on a perceived cost benefit analysis: an effectiveness of **30%** was assumed (without any supportive data).
- For a male of average foot size, increasing the minimum stair going from 250 mm to 280 mm, would have reduced the incidence of a large overstep by **94%**.
- The NCC fails to define a nosing. AS 4586:2013 provides an integrated result where the critical portion of the nosing is not measured.



Since the greatest wear on descent is at nosings, the use of slip resistant nosings on steps with short goings is likely to lead to wear and rapid loss of slip resistance.

The NCC 2014 slip resistant nosing requirement may thus be of limited long term benefit.

The ABCB, not the ACCC, is responsible for both the initial and long term safety of building products.



Falls in Elderly people

- Are a major health burden, especially in the long-term care environment.
- Yet little objective evidence is available for how and why falls occur in this population.
- We aimed to provide such evidence by analysing real-life falls in long-term care captured on video.
- 264 digital video cameras were installed in common areas over 26 month period.

Robinovitch *et al*, Lancet (2013)

Captured 227 falls from 130 individuals

41% incorrect transfer or shift of bodyweight

21% trip or stumble; 11% hit or bump

11% loss of support with external object

11% collapse or loss of consciousness

3% slip; 3% could not tell

The three activities associated with the highest proportion of falls were forward walking (24%), standing quietly (13%), and sitting down (12%).

Mean age: 78 years old

Robinovitch *et al*. (2013)

- "Our study provides the first comprehensive evidence, based on video capture, of the mechanisms of falls in the high-risk long-term care environment".
- **Our results show that the causes of falls in this population are different than described previously,** with most being due to self-induced weight shifting, and occurring with equal frequency during walking, transferring, and standing.

Lancet, 2013 January 5

Slip reconsideration

- Increased slip resistance will not prevent falls due to self-induced weight shifting.
- The low rate of slips implies well maintained sufficiently slip resistant floors.
- Tarkett iQ Optima vinyl flooring was used in the general areas. It has R9 slip resistance in the USA and Europe, but R10 in Australia!?!
- Its class W result of 49 BPN implies class P4.
- Slips generally have environmental causes, but can have biomedical causal contributions.
- Self reporting of fall causation is unreliable

Just rights and sensible entitlements?

Fall injuries from **all causes**, arise due to some shortcoming of the **facility** (environmental) and /or the **pedestrian** (biomedical or behavioural).

Slips and trips have environmental causes, but why was the hazard not identified? (& by whom?)

Stumbles, tumbles & crumples increasingly have **biomedical** contributions/causes.

Proactive environmental falls prevention research outcomes should limit incidents, prolong the quality of life, and reduce disability insurance payouts.

Appropriate Universal Design flooring <u>solutions</u> should be utilised to promote broader widespread community adoption of Universal Design.