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SLIP RESISTANCE
REVIEW OF THE DRAFT STANDARD

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An American colleague recently observed that the German slip resistance standards had very little impact on the choices of tile that were used in commercial buildings in the USA. Was this also true of Australia, where the German slip resistance requirements had been adopted as recommendations in Standards Australia Handbook 197:1999, *An introductory guide to the slip resistance of pedestrian surfaces?* we had also introduced the German ramp tests in AS/NZS 4586: 1999, *Slip resistance classification of new pedestrian surface materials*.

This question caused me to wonder whether the adoption of the German standards had reduced the incidence of slip-related accidents. Given that the Australian slip resistance standards, AS/NZS 4586 and AS/NZS 4663, Slip resistance measurement of existing pedestrian surfaces, are in the process of being revised[1], this is an opportune moment to reflect on the individual test methods and how they are used.

In this context, a particularly pertinent question would be "Do we place too much blind faith in the absolute accuracy of inclining ramp (or other types of) slip resistance test results?"

Proposed major changes

The proposed major change to the standards relates to the wet pendulum test, which will require that the rubber slider is prepared on a lapping film when testing smooth surfaces. This will bring the standards into line with BS 7976, *Pendulum testers*.

As reported in the December 2004 issue of *Tile Today*, in 'Slip resistance and social responsibility' (issue 45, page 30) it had been anticipated that use of the lapping film would be adopted when the AS/NZS 4586 and AS/NZS 4663 standards were revised in 2004. Use of the lapping film yields a smoother surface on the rubber test foot, and mitigates against the pendulum test result being an artefact of the roughness of the rubber.

Use of a smoother rubber test foot allows lower readings to be obtained on some smoother pedestrian surfaces. This effectively extends the critical bottom end of the pendulum scale, and allows better discrimination between very slippery and not so slippery products. This is an excellent outcome from a safety perspective.

One crucial outcome of the changed test foot preparation is that some products will receive a lower wet pendulum slip classification, where this is due to substantially lower results rather than having results that are close to the transition between classifications. Some products will fall from class X to class Z. This fact may explain

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why some people have slipped on floors that appeared to be safe, based on achieving a minimum coefficient of friction (COF) of 0.4, when the floor has been tested.

A more extensive pedestrian flooring selection guide, based on minimum pendulum or ramp recommendations for specific locations, has been made available for public comment in Appendix H of DR 07066 CP. This expanded set of modified and simplified recommendations will become a focus of a revised HB 197, but is unlikely to be published in AS/NZS 4586. These proposed recommendations make use of the Y classification. However, any detailed discussion of them will be deferred until after receipt of public comment.

Extreme caution should be exercised regarding the Appendix H recommendations. They relate to classifications that are based on the new method of rubber test foot preparation. If the intended wet pendulum recommendations are used in conjunction with the existing classifications, the consequences could be disastrous (if the product selected is one that would have a lower classification with the new method of rubber preparation).

It is anticipated that the new standards will be published at the same time as a revised HB 197. The need to ensure that test reports are relevant will be made most explicitly.

Most products that change classifications have an Rz surface roughness of less than 10 microns. Some test houses have been providing complimentary surface roughness results as they only take a few minutes to make. Those products that have an Rz surface roughness of 20 microns or more will continue to be tested using a rubber test foot that is prepared with 400# grit paper. For such products, existing test reports will remain valid. There will be an extensive publicity campaign once the standards are finalised and their publication date is determined.

New definitions

It is proposed that use of the TRL rubber will extend to the X, Y and Z classifications, rather than just classes V and W. It is known that use of different (Four S and TRL) rubbers may result in the one product receiving different classifications, but this situation has existed since AS/NZS 3661.1, *Slip resistance of pedestrian surfaces*, was first published in 1993.

Four S rubber is used in most wet pendulum tests of flooring surfaces. It is anticipated that the TRL rubber will be principally used for assessing coarse external paving surfaces and for auditing wet barefoot areas.

There are a number of new definitions including:

- **Profiled Surface**: a surface with a designed raised geometrical pattern that provides volumetric displacement.
- **Structured surface**: an irregular surface, possibly produced to provide enhanced slip resistance.

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- **Slip resistance value (SRV)**: The SRV is the mean BPN value for the sample that has been tested, regardless of whether the surface was level or on a slope.
- **Slope design value (SDV)**: The SDV is the mean BPN value required on a slope of a known maximum gradient. The SDV may be calculated by using the tables that are given in Appendix G, using the minimum SRV that is considered appropriate for a level surface.
- **Slope correction value (SCV)**: When the slip resistance of a sloping surface of known maximum gradient is measured, the SCV is an adjusted SRV, giving a value equivalent to that of the equivalent SRV for a level surface.

It is hoped that widespread use of SRVs (as a new term) will help differentiate between the existing and new (2007) test methods. The use of this term on product literature should indicate that it is up to date.

Appendix G contains tables that can be used to calculate the SDV and the SCV, as well as examples of calculations for wet pendulum and dry floor friction test results. It is hoped that this guidance will help prevent any calculation errors, particularly when selecting products for sloping areas, which are predominantly external.

If a periodical audit yields low SCVs, remedial treatment may be required.

There are no significant immediately proposed changes to the ramp test methods.

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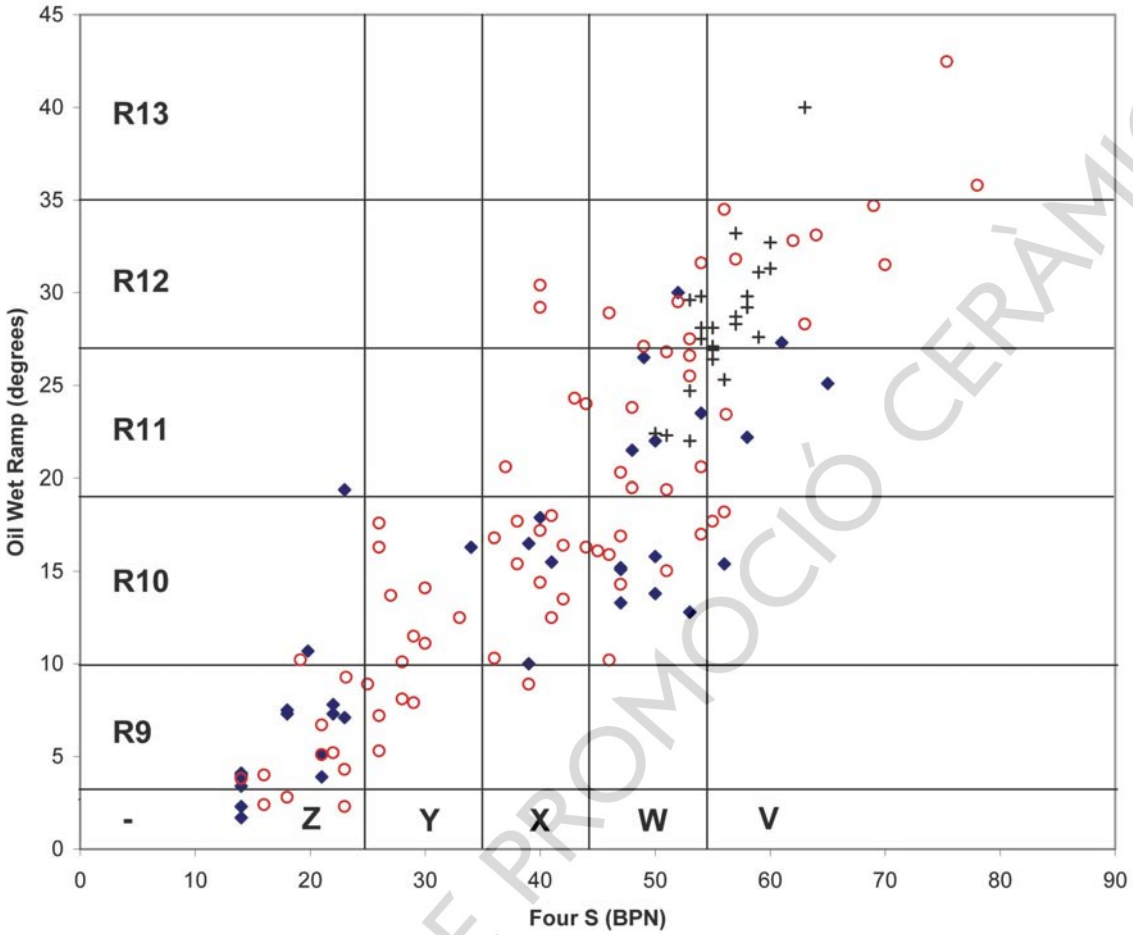

A comparison of oil-wet ramp and wet pendulum slip resistance results for some ceramic tiles, in the context f the AS/NZS 4586 classifications. Glazed tiles (◆) porcelain tiles (○) and terracotta tiles (+).
Figure 1

Real world review

In returning to my opening remarks, it is hard to know exactly what impact our adoption of the German ramp tests has had. There has certainly been a marked trend towards R ratings to the detriment of pendulum results. Firstly, this is probably because of the ready availability of ramp ratings from many European manufacturers, and secondly, the wider range of areas detailed in the German regulations (Table 5 as compared to Table 3 in HB 197). Nobody seems to have undertaken any follow-up research to determine whether this has reduced the incidence of slips and falls.

I have always maintained that the optimum solution is for products to comply with both the pendulum and the ramp recommendations. I still do. However, before considering whether I have a preference for either method, it is appropriate to reflect on Figure 1, which compares oil-wet ramp and Four S wet pendulum test results for some hard surfaces. It can be seen that the R10 products had wet pendulum classifications that varied from class V to class Z, and class X products had oil-wet classifications that varied from R9 to R12. It is possible that some of the products might have received lower pendulum results if the test foot had been prepared with lapping film.

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For the slip resistance testing of most products, I lean towards the British tile industry position. They consider that pendulum results should be used for normal conditions, and ramp results for special conditions. I regard normal conditions as being domestic situations and most commonly accessible public areas. Special conditions predominantly relate to industrial situations where footwear should be controlled, as well as those areas that are almost exclusively used by staff or visiting workers. The contaminants in such areas may well be other than water. Wet barefoot areas are a specific special condition.

Where the public is concerned, the most likely contaminant is water and one worst case scenario is somebody wearing shoes that have no tread. The British Health and Safety Laboratory (HSL) has chosen to base their wet shod ramp test on Four S rubber and potable water. Preliminary research results have indicated that Four S rubber-shod shoes provide less slip resistance on water-wet smooth surfaced hard finishes than footwear with a treaded pattern.

Comparisons of the CoF obtained from Four S rubber-shod water-wet ramp tests and pendulum tests have generally shown reasonable agreement. The exceptions to this have generally been on surfaces that have been heavily textured and/or profiled. This leads one to question which test method is more suitable for testing structured and profiled surfaces.

Given that the wet pendulum results for tactile ground surface warning indicators are essentially a function of how the test specimen is positioned, it would seem that ramp tests are likely to be more appropriate for testing many structured and profiled surfaces.

While there appears to be a move towards Four S rubber-shod water-wet ramp testing in Europe, is this sensible if the test can only be conducted in the laboratory? If the results are generally in agreement with the pendulum, and the pendulum test can be conducted on site whenever required, and also takes less time and costs less, where is the logic in switching to Four S rubber-shod water-wet ramp tests?

HSL has a high degree of confidence in the pendulum test method for assessing the slip potential of floors under fluid contaminated conditions. The Health and Safety Executive has adopted the pendulum test as its preferred method for assessing the slip risk posed by floors for use during enforcement and prosecution.

If one believes in the accuracy of the pendulum test, one can accept ramp results that underestimate the CoF of a water-wet floor compared to data generated by the pendulum test. A floor specified on the basis of the ramp results would tend to be 'fail safe', in that it could demonstrate higher levels of slip resistance when installed than might be expected based on the ramp results. However, those ramp results that overestimate the slip potential are a potential cause of concern.

Although there is no problem if the ramp-derived CoF is accurate, this implies that the pendulum result was inaccurate. As previously reported, the pendulum test may

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underestimate the slip resistance of warped specimens as the 75 mm wide test foot may make relatively little contact with the specimen. A shoe heel or a rounded sole may have a significantly higher proportion of the footwear in direct contact with a contoured surface. The same may be true of some profiled and structured surfaces.

Another important question is "How does this relate to the oil-wet and wet barefoot ramp tests?"

There is an extended version of this paper at www.infotile.com.au, which considers several aspects of how the ramp tests are conducted. It includes a case study where a tile merchant learned a lot about ramp tests the hard way. Hopefully this case will initiate some positive changes. The web version also has a link that will allow you to comment directly to the author.

Conclusion

This review is intended to provoke comment and to initiate debate throughout the flooring and slip resistance communities, as well as in several other international standards committees. My responsibility is to ensure that the process of standardisation is as transparent as possible.

Some contracts contain a 'Warranty of slip resistance by the manufacturer' clause, which may require: "The manufacturer shall warrant that the product(s) used in the Works that their initial ex-factory slip test rating shall be capable of being sustained at that minimum level for the perceived working life of the product(s), nominated at 10 years, subject to the manufacturer's maintenance recommendations being followed".

Since projects get completed, such assurances are presumably provided. However, few slip-resistant hard surfaces retain their ex-factory slip resistance. Stone can be honed just enough to become class R10, a little bit of foot traffic will polish it back to R9. Whether or not they retain their rating (as in classification rather than declared result) is another issue. In the case of product that has been specified in terms of ramp classifications, it is arguably impossible to determine whether the classification has changed unless a section of the floor is removed. Determining the sustainability of slip resistance is the next big issue that has to be addressed.

My experience is that architects and tile merchants tend to consider published slip resistance classifications as akin to insurance policies. Greater regulation of the ramp test procedures might ensure that they are conducted in the intended spirit, so that any unbridled faith in the results might have a firmer foundation.

When considering the impact of ramp tests on the provision of an improved slip resistant environment, we have yet to capture the necessary data. We need to consider the effects of wear, contamination and maintenance, as well as how we relate any pendulum audit data back to the original ramp test data, which is often unavailable.

Given that the pendulum is well suited to quality control testing of product, and that it can be used to monitor slip resistance after installation, greater faith in pendulum results would seem appropriate.

We cannot trust European slip resistance results for stone because of the lack of control over the rubber test foot preparation (March 2005, issue 7, *Discovering Stone* 'Beware of conflicting stone slip resistance reports' page 26). It is essential that we immediately adopt the use of lapping film for preparing rubber test feet when testing smooth surfaces. This should add a factor of safety to the processes of selecting products and when monitoring their in-situ performance.

We can resolve any issues associated with ramp testing at a later stage, since most people seem to have been blissfully unaware of any problems until now.

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Footnotes:

[1] *DR 07066 CP Slip resistance classification of new pedestrian surface materials*, and *DR 07067 CP Slip resistance measurement of existing pedestrian surfaces*, are available for public comment until 8 March 2008, at http://wwwsaiglobaLcomlshopIScriptIFreeDownlood.asp?DocN=MSWD07066ATCRD and http://wwwsaiglobaLcomlshopIScriptIFreeDownlood.asp?DocN=MSWD07067ATCRD respectively

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