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# INADEQUATE COLOUR CONTRASTS AND OTHER ILLUMINATING CONSIDERATIONS

*When we asked Richard Bowman to write about a typical day in his working life, he conveyed some of the benefits gained from attending Qualicer in Spain. While such work may sound like a jaunt to some, the success of such conferences is also a function of the quality of the work that the participants perform in their various daily capacities. Richard has kept readers informed about standards developments, but what initiates such work? In providing an interim solution to a previously unrecognised problem, Richard now uses several standards to reflect a different work function, while throwing further light on our perception of visual appearance.*

Tiling experts frequently caution against selecting tiles on the basis of aesthetics alone, as there are several functional requirements that should be considered. While there is more to a tile than appearance, there is more to appearance than we generally appreciate.

Modern processing techniques can result in surface and sub-surface appearance phenomena that, individually and in combination, defy adequate visual or instrumental specification. This limits our ability to define and consistently manufacture products of desirable appearance, or analyse and exclude those of inferior quality.

In 1994, Mark Newall, an English architect, presented his own idiosyncratic view of flooring selection criteria: ‘Architects care most about what a product looks like. This is also the second and third most important factors. After this comes the rest. To put it bluntly, price is the client’s problem, availability is the contractor’s problem and performance is the manufacturer’s problem; the architect’s problem is to get some great photos at handover’. He might also have stated ‘A test house is paid to deliver results; interpreting them is someone else’s problem’. As this paper shows, in order to conduct a test, you first have to understand how the test should be performed, particularly if a standard is insufficiently explicit.

While it is not CSIRO’s responsibility, it has assumed substantial (unfunded) ownership of the problem of how to ensure that the ceramic tiling standards are as relevant as possible. This means that the standards should be sufficiently intelligible to those who have to use them, so that there should be minimal interlaboratory variability. Establishing standards that can provide useful information to manufacturers, merchants and consumers is an associated problem.

This paper identifies a serious problem in that there is no clearly defined test method for demonstrating compliance with the BCA requirements for contrasting colours. It offers an interim solution, but also raises other aspects that will need to be considered. Since the design of a suitable colour scheme and the selection of a suitable light source are interdependent problems, it necessarily raises some aspects of lighting system design and performance. Hopefully this material will facilitate the realisation of tiling systems that create a better visual environment, while promoting efficiency and well-being in workplaces, and safety in public areas.

## What is a contrasting colour?

AS 1428.1 - 1998, Design for access and mobility: General requirements for access - New building work, includes requirements for stairways: ‘Where the BCA requires compliance with this Clause (9) and where access is required for persons with non-ambulatory disabilities, the stairway shall comply with this clause (9)’. Clause 9 includes a note that ‘For vision-impaired persons there should be a strip of contrasting colour (e.g. a painted white line) or texture at least 25 mm wide on the tread at the nosing’. Since compliance with the BCA (Building Code of Australia) is mandatory, how

does one determine what is an adequate contrasting colour or texture? Furthermore, does this colour contrast requirement apply to both the tread and the riser, or just the tread?

The question of 'what is a contrasting colour' is perhaps best solved by reference to AS 1428.4 - 1992, Design for access and mobility: Tactile ground surface indicators for the orientation of people with vision impairment. Clause 6.1 requires that 'Tactile indicators shall have a colour contrast to that of the adjacent surface. The colour shall provide a luminance contrast to the surrounding surface of not less than 0.3 (30%)'. Yet what does this mean?

The 1993 Australian Bureau of Statistics Survey revealed that 18% of the Australian population (3,176,000 people) had a disability. This included 261,700 people with partial loss of sight and 17,000 people with total loss of sight, and 3340 persons using canes. There were also 499,300 users of mobility aids (including 84,000 users of wheelchairs).

AS 1428.2 - 1992, Design for access and mobility: Enhanced and additional requirements - Buildings and facilities, also requires that door handles 'shall be clearly identified by colour with luminance contrast to their background of not less than 0.3 (30%)'. There is also a note pertaining to signs warning of danger: 'Where audible signals are not considered necessary, the most satisfactory warning is the provision of changes in both texture and colour to provide a luminance contrast with the background of not less than 0.3 (30%)'. In the case of stairway handrails, the word "factor" is introduced: 'Where there is a background wall, handrails shall have a luminance contrast factor with the wall of not less than 0.3 (30%)'.

AS/NZS 1906.1 - 1993, Retroreflective materials and devices for road traffic control purposes, contains a guide to the minimum desirable luminance contrast ratio between legend and coloured background on a sign having both legend and background reflectorized. Clause C2 of appendix C, Daylight colour and luminance factor test, states 'Daylight colour and luminance factor measurements shall be made with either a spectrophotometer or a colorimeter. The instrument geometry shall be 45° illumination and normal viewing (45/0) using CIE illuminant $D_{65}$'.

AS 3665, Simplified definitions of lighting terms and quantities, provides definitions for luminous flux, luminous intensity, luminance, illumination, illuminance, reflectance and luminance factor, but not for contrast or luminance contrast. Luminance is the 'physical quantity corresponding to the brightness of a surface in a specified direction, and is measured in units of candela per square metre. Illuminance is the physical measure of illumination, a general expression for the quantity of light arriving at a surface. Illuminance is measured in lux (lx). Luminance factor is 'the ratio of the luminance of a reflecting surface in a given direction to that of an ideal white diffusing surface when viewed in the same direction and when illuminated in the same way. Usually expressed as a decimal in the range 0 to 1 where the surface has a matt finish but values of greater than 1 are possible if the surface is shiny'.

The AS 3665 definition of luminance factor also notes 'The luminance factor is commonly specified for the following conditions: (a) light incident at right angles to the surface; and (b) measurements made at 45 degrees to the surface. By convention this combination of conditions is designated as 0/45'.

AS/NZS 2633 - 1996, Guide to the specification of colours, describes the various systems that are in use for specifying colours and includes specific recommendations to assist in the selection of an appropriate method. Guidance is also given on the specification of tolerances.

The CIE approach to colour specification permits the identification of about five million colours. This system use two values (x, y) to specify the colour of the sample and a third value (Y) to specify the luminance, illuminance, luminous reflectance or luminous transmission (as is appropriate to the application). Such measurements can be made with a tricolorimeter, an instrument that has a photosensor and three colour filters, or three photosensors each with its own colour filter. Although tricolorimeters make a direct reading of the numerical values of colour, it should be noted that there is scope for substantial interinstrumental variations due to the difficulties in matching filter/detector sensitivities to the ideal.

The simplest means of assessing colour differences is to make a subjective judgment as to whether there is an acceptable difference. However, if this method of setting tolerances is to be used, the means of making the comparison should be specified including reference to the illuminant/s to be used, as well as the illuminating and viewing geometries. Colours may match under one light source but appear very different under another. The appearance of colours can be affected by changes in the illuminant, and the illuminating and viewing geometries. It would thus appear that in order to determine whether there is sufficient contrast between two tiles, one must use the same instrument to determine the x, y and Y colour values.

AS 2700 - 1996, Colour standards for general purposes, presents and specifies reference colours for use in choosing colour schemes in the industrial, architectural and decorative areas. This Standard lists the tristimulus value Y of 206 colours, amongst other colorimetric data. These colours were produced within a gloss range of 25 to 40% measured at a 60 degree gloss angle. For example, the current Australian ‘national colours’, Homebush Green and Homebush Gold, have luminance values of 19.0 and 61.0 respectively. Yet how does one use these figures to calculate whether the contrast is greater than 0.3 (30%)? Presumably these are mathematically equivalent, where one contrast is expressed as a decimal in the range 0 to 1, and the other is expressed as a percentage.

AS 1852.845, International technical vocabulary: Lighting, defines contrast as ‘In the physical sense: Quantity intended to correlate with the perceived brightness contrast, usually defined by one of a number of formulae which involve the luminances of the stimuli considered, for example: $\Delta L/L$ near the luminance threshold, or $L_1/L_2$ for much higher luminances’.

AS 2422, Glossary of micrographics terms, defines contrast in the objective sense as ‘quantities defined by the following expressions, for luminance contrast:

(a) = $(L_2 - L_1) / L_1$

(b) = $(L_2 - L_1) / 0.5 (L_1 + L_2)$

(c) = $L_2 / L_1$

Expression (c) is also known as the ‘luminance ratio.’

ASTM E 284-97a, Standard terminology of appearance, defines contrast as ‘the degree of dissimilarity of a measured quantity such as luminance of two areas, expressed as a number computed by a specific formula’. The ensuing discussion states:

> ‘The following formulas for the luminance contrast between areas having luminance $L_1$ and $L_2$ (where $L_2$ is the larger) have been adopted by the CIE:
>
> $C_a = (L_2 - L_1) / L_1$

$C_b = (L_2 - L_1) / 0.5 (L_1 + L_2)$

$C_c = L_2 / L_1$

The following formulas are also in use:

$C_d = L_2 - L_1$

$C_e = (L_2 - L_1) / L_2$

$C_M = (L_2 - L_1) / (L_2 + L_1)$

If the illumination of the areas of interest is uniform and constant, the luminances are proportional to the reflectances and these quantities may be used in place of luminances in these formulas. The simple ratio, $C_c = L_2/L_1$, is usually used in ASTM standards.'

**An interim solution**

The AS 1428.4 requirement that the 'colour shall provide a luminance contrast to the surrounding surface of not less than 0.3 (30%)' does not appear to be expressed in the form of the $C_c$ ratio. It is understood that some people advocate the use of $C_a$, and others $C_e$. The argument might best be based on which colour is predominant in the field of view. However, if one follows this hypothesis to its logical conclusion, one would presumably derive an equation of the form $L_2 - L_1 / (aL_1 + bL_2)$, where a and b total one and represent the proportion of materials 1 and 2 that are in the field of view as one descends the stairs. This would be a function of the tread to riser ratio and the height of the observer. Since this is obviously a matter for the relevant committee to determine, perhaps the best interim guidance is to use $C_b$. This at least permits the data that is given in AS 2700 to be used for fundamental design purposes.

One can calculate that if $C_b$ must be at least 0.3, then $L_1$ must be less than 0.74 $L_2$ (or $L_2$ must be greater than 1.35 $L_1$). Thus, in order to achieve a satisfactory contrast with white ($L_2$ = 90.4), one would have to use a colour with a luminance of less than 66.9. In the case of black ($L_1$ = 4.3), one would have to use a colour with a luminance greater than 5.8. It can be seen that the minimum acceptable luminance differences can vary significantly (23.5 versus 1.5). In the case of an intermediate colour such as sky blue (L = 47.7), colours with a luminance greater than 64.4 or less than 35.3 would be acceptable.

Table 1 gives some typical luminance values of some porcelain step treads and tactiles, determined using diffuse light, normal viewing and CIE illuminant $D_{65}$. There was no discernible change in luminance after soaking these tiles in water for 30 minutes. Since such tiles are often manufactured from a number of differently coloured spray dried powders, the tile surface may be comprised of a number of colours, as shown in Figure 1. The variable distribution of these colours can cause some variability in the luminance within an individual specimen. There will also be some variability between batches due to shade variations.

Clause 3.4 of AS 2633 states that 'For a coloured surface, it would be necessary to give the minimum and maximum values of Y to define the permitted range of luminous reflectance'. Although some guidance should be provided as to whether the mean, minimum or maximum luminance values should be used to calculate colour contrasts, use of the mean value facilitates calculation of an unacceptable luminance contrast range. Some allowance should also be made for shade variation.

Table 1 Mean luminance results and unacceptable colour contrast range for some porcelain tiles

| Colour | Mean luminance | Unacceptable luminance range |
|---|---|---|
| Charcoal - dark | 7.6 | 5.6 - 10.3 |
| Charcoal - light | 8.4 | 6.2 - 11.3 |
| Black | 14.9 | 11.0 - 20.1 |
| Terra | 22.2 | 16.4 - 30.0 |
| Cobalt | 26.6 | 19.7 - 35.9 |
| Yellow | 27.6 | 20.4 - 37.3 |
| Rose | 31.4 | 23.2 - 42.4 |
| Steel grey | 32.1 | 23.8 - 43.3 |
| Mustard | 38.2 | 28.3 - 51.6 |
| White | 51.0 | 37.7 - 68.9 |
| Ivory | 55.9 | 41.4 - 75.5 |

**Possible complications**

People with a sight disability expect that there will be adequate contrast in all the lighting and weather conditions that the stair might be exposed to. The darkening of colour that commonly occurs as porous materials absorb water poses obvious design problems. While it is quite simple for a manufacturer to determine the luminance of a product under dry and saturated conditions, there is far less control over the colour of concrete and bituminous paving materials. One might also need to consider to what extent an allowance should be made for colour changes due to soiling or deterioration of surface finishes.

Concrete can vary tremendously in colour, particularly when it has aged. While dry concrete might initially be very light grey to medium light grey in colour, it may subsequently darken or attain a more yellowish, greenish or brownish appearance. Table 2 shows the effect of wetting on some new light grey concrete and some unglazed ceramic tiles. It can be seen that concrete 4 did not darken as much as the other concretes. When wetted, the concrete generally lost more luminance than the porous unglazed ceramic tiles. Bituminous pavements also vary considerably in colour, depending on the relative amount of bitumen and the type of aggregate that is used.

Table 2 Summary of luminance results and unacceptable colour contrast range for some concretes and unglazed ceramic tiles

| New concrete and porous unglazed ceramic tiles | Mean luminance, dry | Mean luminance, wet | Unacceptable luminance range |
|---|---|---|---|
| Concrete 1 (very light grey) | 37.1 | 17.2 | 12.7 – 50.1 |
| Concrete 2 | 30.8 | 14.8 | 11.0 – 41.6 |
| Concrete 3 | 27.0 | 11.8 | 8.7 – 36.5 |
| Concrete 4 (medium light grey) | 23.6 | 20.2 | 14.9 – 31.9 |
| Moderate reddish brown | 18.8 | 15.3 | 11.3 – 25.4 |
| Dark yellowish brown | 20.3 | 15.0 | 11.1 – 27.4 |
| Light brown | 29.1 | 25.0 | 18.5 – 39.3 |
| Dark yellowish orange | 35.6 | 30.6 | 22.6 – 48.1 |
| Medium yellowish orange | 39.3 | 32.2 | 23.8 – 53.1 |
| Pale yellowish orange | 48.1 | 40.1 | 29.7 – 64.9 |
| Greyish yellow | 59.7 | 52.8 | 39.1 – 80.6 |

Since architects rarely specify the precise colour characteristics of concrete pavements and stairways, one might conclude from Table 2 that in order to provide a luminance contrast of 0.3 with

concrete, a product should have a luminance less than 8.7 or greater than 50.1. This excludes most of the products in Table 1. However, we do not have to live in a grey world with black and white contrasts.

The specification of coloured pavers or ceramic tiles enables a wider range of contrasting colours to be used. However, manufacturers of products that change their colour when wetted should expect that they will have to provide appropriate data for design purposes. In the case of dark bituminous pavements, one can obviously obtain the required contrast with light colours. Given that light coloured bituminous surfaces darken when wetted, one may have to determine the acceptability of various products based on site testing. This is certainly feasible in the case of existing pavements, but one should anticipate that the colour may change due to subsequent maintenance regimes.

The designer's task is certainly easier when it comes to internal stair nosings. It can be seen that if one chooses a nosing with a moderate luminance, one can both fill the rest of the tread with a darker colour and use a lighter colour for the riser.

External stairways will obviously be subjected to a variety of illumination conditions throughout the year. The colour of an object that reflects light depends on both the spectral reflectance of the object, and on the spectral energy distribution of the light illuminating the object. Where a colour in a practical application is likely to be illuminated by different sources of light, e.g. daylight and incandescent light at night, it may be necessary to specify that the colour shall comply with the colour specification under more than one illuminant. One should particularly consider the behaviour of fluorescent materials, as their colour is very dependent on the amount of ultraviolet radiation emitted by the illuminating light source. For fluorescent media, the luminance factor is the sum of two quantities, the reflection luminance factor and the fluorescence luminance factor. Both the appearance of colours and the measured numerical values of colour can depend quite markedly on the angle of incidence of the illuminant and the angle of observation.

Clause 5.3.1 of AS 2633 provides some guidance for the setting of tolerances when visually assessing colour differences. It also warns that there are individual differences in the perception of colours so that different observers may not make the same judgment. AS 1580.601.1 - 1995, provides a visual test procedure for the comparison of colours in a standardised lighting booth. Such booths can be fitted with 'daylight' illumination, 'incandescent' illumination and an ultraviolet light source. The specified booth uses an artificial daylight of specified intensity and spectral composition in order to overcome the variability of natural daylight in both quantity and quality. It also cautions that the viewer should avoid wearing strongly coloured clothing, which may influence the colour assessment.

Clause 6.12.3 of AS 1680.1 - 1990, Interior lighting - General principles and recommendations, and Table E1 of AS 1680.2.1 - 1990, Interior lighting - Circulation spaces and other general areas, both include the statement that 'A single, bold, contrasting stripe set back about 35 mm from the front edge of each tread on an escape stairway helps to make the stairway quicker and safer to descend in an emergency'. This is inconsistent with AS 1428.1, where it is noted that 'For vision-impaired persons there should be a strip of contrasting colour (e.g. a painted white line) or texture at least 25 mm wide on the tread at the nosing'. The question of what constitutes an adequately contrasting texture has still to be resolved. One should also consider maintenance requirements when determining the extent to which a painted white line will satisfy the BCA slip resistance requirements.

The note in AS 1680.2.1 also warns that the single, bold, contrasting stripe ‘is more effective than multiple striping, especially in the relatively dim illumination provided by emergency lighting’. There are several proprietary metallic nosings that have a number of parallel in-fills of variously coloured ‘slip resistant’ materials. Luminance measurements are typically made on an area 8 mm in diameter (or within a range of 3 to 50 mm, depending on the instrument). How does one determine whether such multi-coloured products (and concretes with exposed aggregates) have an adequate colour contrast? Perhaps the proprietary nosings have adequate texture contrast.

**Lighting influences**

AS 1680.1 sets out basic recommendations for the creation of good seeing conditions in buildings by means of appropriate lighting and good colour treatment. The aim of the recommendations is to create a visual environment in which the essential task detail is made easy to see and adverse factors that may cause visual fatigue are either excluded or appropriately controlled. While the provision of sufficient illuminance on the task is a necessary element, in many instances task visibility depends more on the way in which light is applied. Furthermore, creation of the comfortable visual conditions which people require in order to maintain efficiency throughout the whole work period depends less on the quantity of light than on factors such as the distribution of light throughout the workplace; the use of suitable finishes on the walls, floor and ceiling; the choice of luminaires with adequate glare control; the elimination of unwanted reflections; and so on.

AS 3827.1 - 1998, Lighting system performance - Accuracies and tolerances: Overview and general recommendations, identifies the factors that influence variability in lighting performance and gives recommendations on how such variability may be contained within tolerable limits in the specification, calculation and measurement of interior and exterior lighting systems. The client, architect or interior designer must supply the lighting designer with the following information in the design brief: task description or area usage; lighting requirements; physical details of the space; reflectances; furnishings and equipment; windows and daylighting; and maintenance regime. Clause 3.3.4 considers the light-affecting characteristics of surfaces. Where a lighting system has surfaces that significantly affect lighting parameters, data on these surfaces should be provided as an input to the design. Appendix C is a guide to information that a client might need to provide as an input to lighting design.

Section 6 of AS 1680.1 gives more detailed information on the role of surfaces with respect to interior lighting. The effect a lighting system creates is strongly influenced by the reflectance and colour of the room surfaces. Clause 6.2 recommends that the reflectance of the principal walls should be between 0.3 and 0.7, and that this usually means an actual reflectance of greater than 0.5 due to the low reflectances of glazing materials. Floors should be as light in colour as practicable, but using very light floors ‘tends to create a maintenance problem’. Clause 6.6 advises that floors should have a reflectance of not greater than 0.4. ‘The use of highly polished floors should be avoided, especially if dark in colour’. Clause 6.8 advises that non-glossy finishes should be used wherever possible. ‘In general, matt finishes provide a more uniform brightness distribution than glossy finishes because they improve diffusion and do not give rise to reflected highlights. Polished or glossy surfaces, particularly if dark in colour, reflect highlights which may cause distraction’.

AS 1428.1 requires that ‘Interior lighting for safe movement within buildings shall be uniform and shall comply with the requirements set out in AS/NZS 1680.0’. The BCA also referenced AS 1680.0 by way of Amendment 4. AS 1680.0 - 1998, Interior lighting - safe movement, requires that ‘A minimum illuminance of at least 20 lx shall be provided throughout the space’. Since AS 1680.0 only references AS 1680.2 in the preface, the recommendations appropriate to specific tasks and activities are not mandatory. However, attention is drawn to AS 1680.2.1, which sets out

recommendations for the lighting of building areas of the same general type that represent ‘good practice’.

AS 1680.2.1 recommends a maintenance illuminance of 160 lx in entrance halls, lobbies and foyers. ‘Care should be taken with entrance areas to avoid a pronounced change of illuminance between inside and outside, both by day and by night. In addition, the luminaires used should be of such a type or located so that persons entering or leaving the area will not suffer a significant loss of visibility resulting from glare from the luminaires’. For internal stairs, the recommended maintenance illuminance is 80 lx where it is measured on the stair tread at any point along the centreline of the path of travel. ‘Lamps and bright parts of luminaires should, as far as practicable, be screened from the view of persons ascending or descending the stairs. Lighting should be arranged to provide a contrast between the treads and the risers. Avoid specular reflections on the treads’. Lamps of warm and intermediate colour appearance and of colour rendering groups 2 and 3 are recommended on stairs.

Section 7 of AS 1680.1 considers light source colour. Light sources have two colour properties related to the spectral composition of their emission. One is the apparent colour of the light that the source emits and the other is the effect that the light has on the colour of surfaces. The latter effect is called colour rendering. The CIE general colour rendering index, $R_a$, is an average figure that gives a general indication of the overall colour rendering properties of a lamp, but the colour temperature of the source should also be taken into account when assessing the suitability of the lamp. Where the appearance of objects within a space is important, presumably such as contrasting stair treads, light sources with a high CIE general colour rendering index may be desirable. In general, light sources with good colour rendering properties (groups 1A and 1B) make surfaces of objects appear more colourful than do light sources with moderate or poor colour rendering properties (groups 2, 3 and 4). Clause 7.5.2 advises ‘The interior colour scheme should not be finally decided until the choice of lamp has been considered, and vice versa. When a pleasing result is of paramount importance, it is recommended that the proposed coloured materials be viewed under the selected source before a final decision is made. Selection of a suitable light source and design of a suitable colour scheme are interdependent problems’. Figure 2 gives an example of how the colour of a tile can be made to appear to change through the use of non-uniform lighting.

Section 8 of AS 1680.1 considers glare and related effects. It also details the typical maximum glare index values for various tasks or interiors. Entrance halls, lobbies, general offices and airport departure lounges require greater glare control than kitchens, dining rooms, corridors, passageways and stairs. A disability effect can result from the short-term change in adaptation that can arise from the brief view of a bright light source, either directly or by reflection. Care should be taken to allow adaptation to change, without visually disabling the observer, by providing a threshold zone where the lighting changes between brightly and dimly lit spaces over sufficient spatial distance, so that the observer can sufficiently adapt at the speed at which he or she is moving.

Section 12 of AS 1680.1 considers the maintenance of lighting systems and equipment. Maintenance of lighting systems keeps the performance of the system within the design limits, promotes safety, and, if considered at the design stage, can help to minimise the electrical load and capital costs. The light output from lamps decreases with time of operating until the lamp fails. Different lamp types deteriorate at different rates. Further, dirt deposition will occur on lamps, luminaires and room surfaces. The texture and inclination of the surface finish will influence the rate of deposition. ‘Glossy and semi-gloss surfaces generally depreciate less rapidly than matt surfaces and are easier to clean. However, consideration should be given to the possibility of unwanted reflections where very high gloss surfaces are used’.

AS 1680.2 comprises a collection of specific interior lighting recommendations for particular tasks and interiors. These typically include a recommendation of the maintenance illuminance and the maximum glare index. The maintenance illuminance is the value of the average illuminance below which it is necessary to take remedial action in terms of maintaining the lighting system. This is obviously less than the initial illuminance (the value of average illuminance which is initially provided by the lighting system, i.e. with new lamps (aged to 100 h), clean luminaires and room surfaces). To satisfy the recommendations of AS 1680, it is necessary, for design purposes, to select an initial illuminance significantly greater than the recommended maintenance illuminance to ensure that, for the maintenance cycle adopted, the average illuminance over the task area or throughout the room will not fall below the maintenance illuminance at any time.

Appendix A of AS 1680.0 considers some lighting issues for the partially sighted. It contains three important reference sources, including 'A design guide for the use of colour and contrast to improve the built environment for visually impaired people'.

**Relief is in sight**

Since we fallible humans prepare standards by a consensus process, we have to anticipate the occasional error or imprecision. As this paper indicates, we have to be cautious when dealing in areas that we are poorly familiar with. Some of us get thrust into several diverse issues where we would not claim to be experts. Adequate research might ensure that we don't get paid for making mistakes. It confers some authority, but doesn't necessarily make one an expert.

Having endured a possibly dull paper, there is definitely some light at the end of the tunnel. We should anticipate that ceramic tile and other paving manufacturers will soon publish the luminances of their pavement and stairway products. This data should be in a user-friendly format that readily permits the identification of suitable colour contrasts. We should also expect that the AS 1428 standards will establish simple luminance contrast design guidelines that address the issues raised in this paper.

Since ISO 10545-16, Ceramic tile - Calculation of small colour differences, and the compliance standard ISO 13006, Ceramic tile - Definitions, classification, characteristics and marking, have just been published, the status of the new AS 4459 Ceramic tile standards will be reviewed in the next issue, but with special emphasis on aspects of colour and appearance.

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Figure 1 A variation in the number of differently coloured spray powders that comprise porcelain tiles, and their size, can be seen with small magnification of the surface.

Figure 2 The appearance of this tile has been partially modified by a colour cast lighting effect.