Connecting People: A Guide to Creative Commercial Stair Design

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In public buildings, architects and designers are being asked to promote social interaction, encourage healthy behaviour, and deliver beautiful, complex spaces that engage users on an emotional level. A well-designed staircase is the focal point in which these aspirations can be achieved.

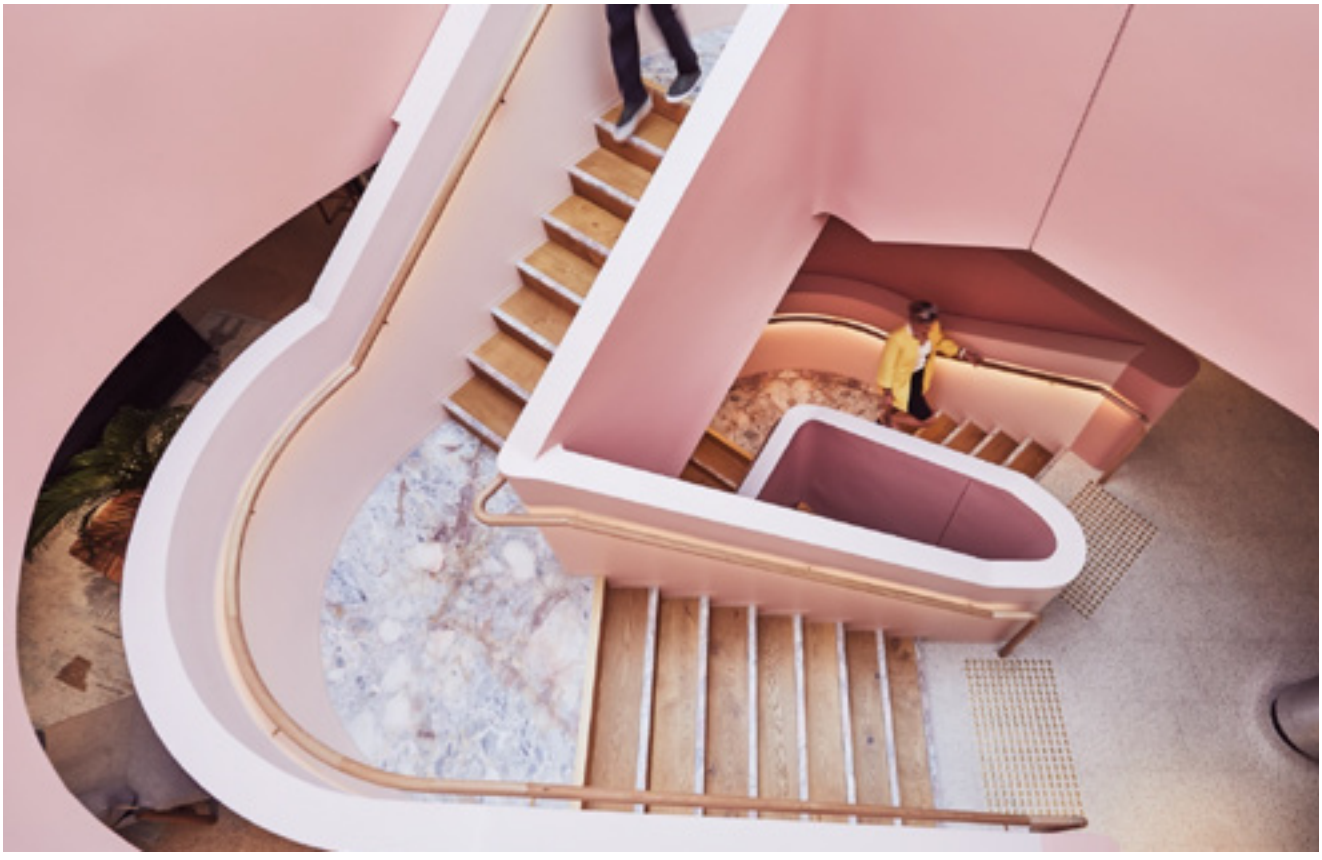
Staircases serve an important purpose – to physically connect one level of a building to another – across split levels, across different floors, or between inside and outside environments. For many projects, this is where staircases stop.

However, stairs in architectural design are not simply practical – they are the centerpiece of a building's character, form and function. In public buildings, architects and designers are being asked to promote social interaction, encourage healthy behaviour, and deliver beautiful, complex spaces that engage users on an emotional level. A well-designed staircase is the focal point in which these aspirations can be achieved.

In the new COVID-19 world, stairs are set to take on even greater importance. With urban space becoming more limited, universities, offices and public buildings are turning into vertical campuses and high rises where moving people to different floors becomes a major challenge. The use of lifts is being challenged, considering the limitations on lift capacity, cost and the growing global anxiety over crowded spaces and the risk of contamination. In the projects of the future, cutting edge stair design will take centre stage.

Against this backdrop, it is important to understand the regulatory requirements for commercial stair design and how they are applied – so that creative and pragmatic approaches to stair design can be utilised to benefit project outcomes. Improperly designed stairs can increase the risk of injury, restrict movement and access, cause discomfort, and lead to non-compliance with building codes and standards.

In this whitepaper, we consider some key regulatory requirements and their best practice application in order to facilitate creative stair design.



Stairs in Architectural Design

Defining Stairs

Stairs are an architectural element used to create a pedestrian route between different vertical levels of a building by dividing the distance into manageable vertical steps[i]. When discussing "stairs", we are generally referring to the staircase, while the term "step" refers to the individual steps that make up the staircase[ii].

In the National Construction Code (NCC), there is a distinction between "non-required" and "required" stairs such as fire escape and fire isolated stairs[iii]. The discussion below focuses on "non-required" stairs in commercial and retail tenancy fitouts, and new and existing commercial and institutional buildings. Residential stair requirements are not identified here.

Stair Shapes

While many aspects of stair design are governed by building codes and regulations, stair shape is determined primarily by the physical constraints of the space, building features and client expectations or vision. The most common stair shapes are listed below:

- Straight flight stairs are stairs with no change in direction. There are several variations to the straight flight stair, including stairs with a mid-landing to break up the flight, stairs with a plinth base and splayed flight stairs.

- Switchback stairs (also called "U-shaped" stairs) feature at least two flights of steps positioned in different directions from each other with a landing between them. Variations of the switchback stair include cantilevered switchback; post-supported switchback; suspended landings; splayed switchback; and right-angled switchback.

- Curved stairs are stairs that follow a large radius or sweeping curve.

- Spiral or helical stairs are stairs that rotate in a circular direction. Spiral stairs traditionally feature a center post from which treads radiate. Helical stairs are free form with typically a balustrade to both sides.

Regulatory Framework for Stair Design

In Australia, regulatory requirements for commercial stair applications are covered in the NCC Volume 1, which includes within its scope Class 2 to 9 buildings, such as tertiary buildings, hotels, office buildings, retail buildings and other public buildings. While the entire Volume includes requirements that directly or indirectly impact stair design, the key section is Section D Access and Egress, particularly Sections D2.13, D2.14 and D2.16.

The following Australian Standards are also relevant:

- AS 1428.1:2009 Design for access and mobility, Part 1: General requirements for access - New building work (see Section 11 on stairways and Section 12 on handrails);

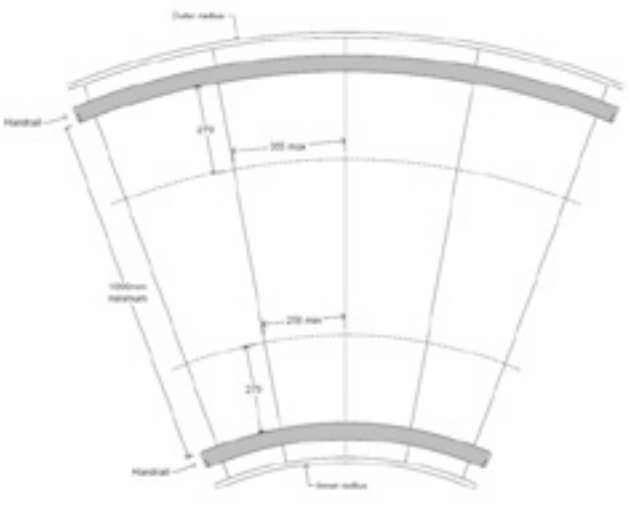
- AS/NZS 1428.4.1:2009 Design for access and mobility - Means to assist the orientation of people with vision impairment - Tactile ground surface indicators;

- AS 1288-2006 Glass in buildings - Selection and installation (see Section 7 on balustrades); and

- AS/NZS 1170.1:2002 Structural design actions - Permanent, imposed and other actions (see Table 3.1, which provides requirements for the applicable loads the stair balustrade will need to take, as well as void edges).

Note that these Standards include requirements that can broadly impact stair design in addition to the sections highlighted above.

If your project includes a broader strategy to achieve a Wellness rating on the building or fit-out, the WELL Building Standard should be considered[iv]. Wellness Standard Feature 64 encourages the inclusion of stairs in building designs as a way to promote low impact physical exercise and includes specific design and aesthetic requirements.



Creative Application of Stair Regulations

When designing stairs to meet the relevant regulatory requirements it is important to establish the key parameters early – the position of the stair, building constraints, and what stair shape works best. Knowing the relevant stair regulations and how to creatively apply them can help deliver a compliant outcome that does not compromise on artistic expression. We discuss several examples below.

Gradient

In the NCC Vol., Table D2.13 provides specifications for riser and going dimensions as follows:

- Riser height (maximum to minimum): 190mm to 115mm.
- Going or tread: 355mm to 250mm.

Table D2.13 also provides the universally-recognised formula 2R+G (for Going), or 2R+T (for Tread), giving a range from 550mm to 700mm. If this is converted to an angle, these dimensions result in a gradient range from 18° at the shallowest to 37° at the steepest.

Stair designs can meet the requirements of Table D2.13 in a variety of ways, however a balance needs to be struck between actual site dimension constraints, the floor-to-floor measurement, the interfacing design of the space, and the user experience.

Stair designs that are fully compliant can still result in a non-ideal stair gradient. Some practical examples:

- A stair that has a riser of 185mm with a tread of 255mm is compliant with the NCC, but results in a relatively steep stair angle of approximately 36°.
- A stair with a riser of 135mm and a tread of 288mm results in a stair angle of 25°. These specifications deliver a more comfortable ascent, but may arguably be too shallow.

User experience dictates that a gradient between 28-32° is the "best practice" target for stair design. This can be achieved with a riser of 162mm and a tread of 300mm, resulting in a gradient of 28.3°. It is important to engage with a specialist stair designer early in the design process as existing building design, soft zones, and slab penetration location will impact stair dimensions. Pre-planning is necessary to accommodate the spatial footprint of a safe, functional staircase.

Spiral Stairs

Spiral stairs must follow the same rules in terms of allowable riser heights, however, for the goings in commercial applications, which will be 1000mm or wider between handrails, it is governed by this extract from Table D2.13:

2. The going in tapered treads in a curved or spiral stairway is measured:

   (a) 270 mm in from the outer side of the unobstructed width of the stairway if the stairway is less than 1 m wide(applicable to a non-required stairway only); and

   (b) 270 mm from each side of the unobstructed width of the stairway if the stairway is 1 m wide or more. *See above diagram for more detail.

In practice, the key issue is whether the minimum and maximum tread dimensions can be achieved with the desired inner and outer radius dictated by the designer. Engage with a specialist early as this aspect of stair design is often incorrectly applied.

Stair Width and Handrail Placement

Practically, most, if not all stairs in commercial applications are required to be compliant with the accessibility standards in AS 1428.1:2009. In Section 12, the following specifications are provided:

- Handrail diameter: 30mm to 50mm.
- Minimum clearance of handrails to wall: 50mm.

While the required minimum width of a stairway is not specified in the text of Section 11 or 12 of AS1428.1, it is demonstrated in Figure 26A, 26B, 26D and 28 that the minimum clearance between handrails is 1000mm.

Based on these dimensions, the resulting internal minimum width of a stair between balustrades is going to be no less than 1162mm with a 32mm handrail or 1200mm with a 50mm handrail. These measurements allow for no tolerance, and have yet to factor in balustrade design and material. Note that for buildings seeking certification under the WELLS Building Standard, the stair width must be a minimum of 1400mm between handrails[v].

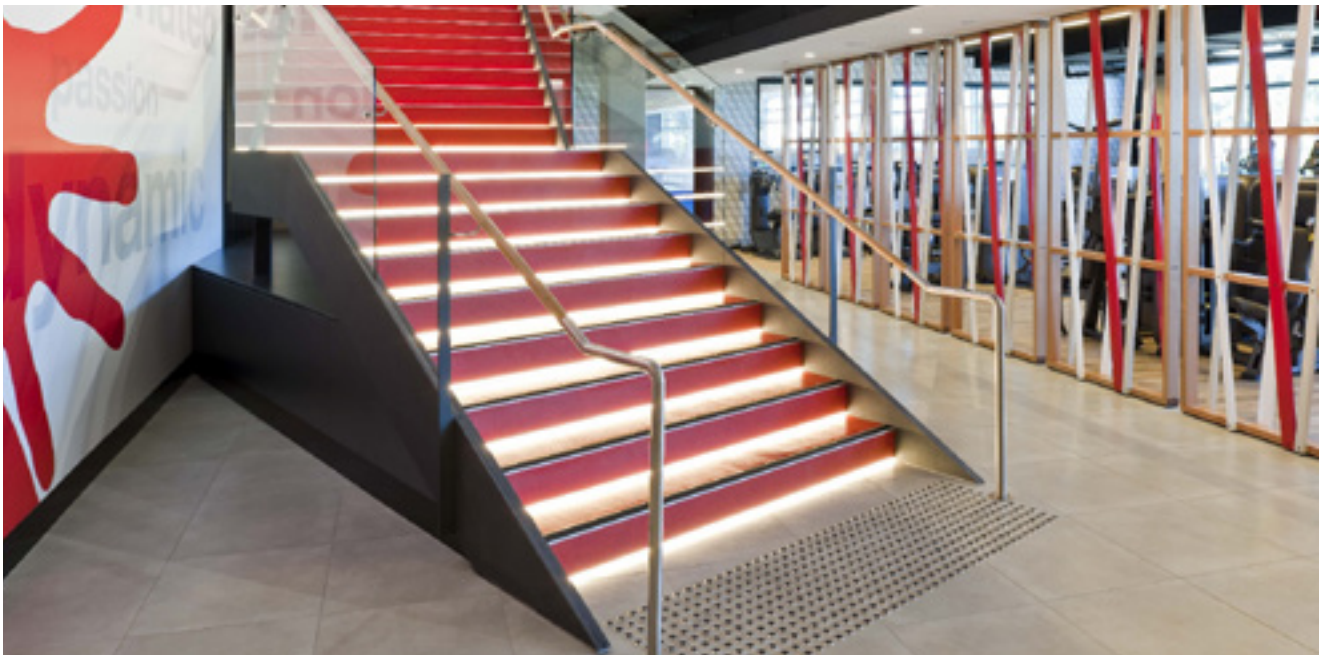
When designing stairs, including handrails and balustrades, sometimes solutions are sought to preserve space. For example, some stair designs move the handrails to the top of the balustrade to save width. However, this approach may cause issues during building certification as there is a conflict between the maximum height of a handrail under AS 1428.1:2009 being 1000mm and the minimum height of a balustrade under the NCC being 1000mm. It is always advisable to install handrails inboard of the balustrade if practically achievable.

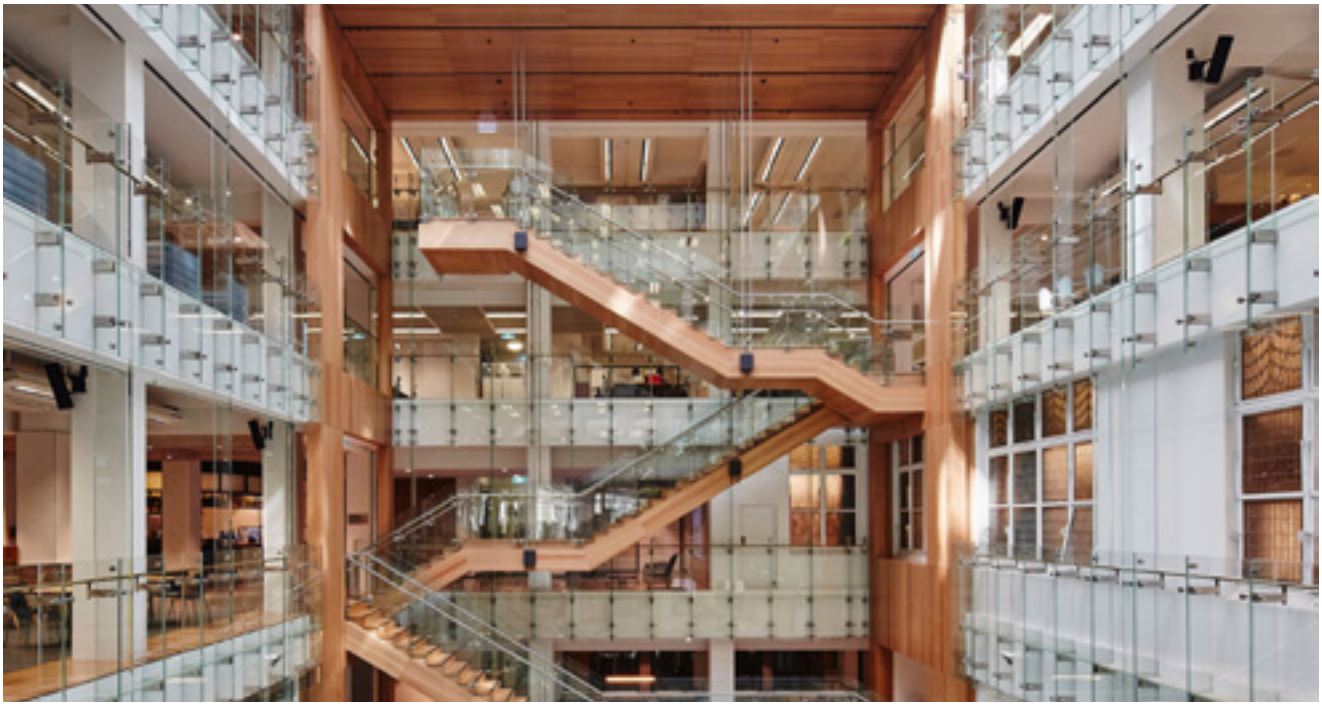
Stair Handrails and Terminations

The NCC imposes relatively few requirements for handrails and terminations that impact stair design. Notable requirements include location of handrail, minimum height (865mm), continuity of the handrail, and minimum clearance from the wall (50mm).

AS 1428.1:2009 provides more detailed handrail design specifications. Some of the key requirements include the required shape, diameter and the geometry of the handrail (particularly at the ends). For example, the Standard dictates a minimum height of a handrail to be 865mm and a maximum height of the handrail of 1000mm. Additional to the 50mm clearance off the wall, handrails must also have a 600mm vertical clear space above the handrail. The minimum length the handrail must run horizontally past the top riser or from the transition point at the base is specified as 300mm before the handrail either returns to the wall, floor or on itself (see Figure 26C)

A common issue when applying these requirements occurs where a handrail gets to the top of a stair and then continues around the stair void. It is good practice to plan for a half or full landing at the top of the stairs of at least 300mm long to allow for the correct handrail geometry. At the base of a stair, the actual dimension of the termination point is not only 300mm, but the tread width and radius plus 300mm.





Materials in Stair Design

Technological and artistic innovation has facilitated modern designs beyond historic stone, marble, and alabaster stairs. The primary consideration in material selection is achieving a balance between serviceability, aesthetics and durability, within budget constraints.

Commonly used tread materials include tile or stone finishes, carpet, and resilient finishes such as rubber, vinyl and woven vinyl. Timber, including solid and engineered boards, is the most popular and is valued for its performance and refined aesthetics. There are a growing number of stairs finished with realistic timber-look vinyl planks, which offer the visual appeal of real timber with comparable performance at an affordable cost.

While the NCC and the relevant Australian Standards provide specific balustrade dimensions, designers have a wide range of options for balustrade materials. This includes glazing (whether frameless or framed), woven or perforated metal mesh, steel plates or pickets, timber pickets, plaster, and timber joinery. Glass is the most popular balustrade material, but there has been a rise in the use of steel plate balustrades in modern building projects.

As with balustrades, the size and positioning of handrails are highly regulated, but material selection is not. In modern design, timber is the most commonly used handrail material. Design trends are seeing a variety of other materials being used for handrails, including steel, brass, painted finishes and leather.

Active Metal

Founded in 1994 as a small Sydney-based architectural metal manufacturer, Active Metal has grown into a national business focused on assisting designers, architects and builders in creating iconic staircases. Active Metal has offices in Sydney, Canberra, Melbourne, Brisbane, Perth and Adelaide and the ability to execute projects across Australia.

A definitive mix of youthful operatives and experienced veterans gives Active Metal the edge in today's market. Blending together 35 years of hands-on savvy, indepth regulatory knowledge and cutting edge technology, the company tailors each project to meet and exceed the individual clients' goals and expectations.

Active Metal bridges multiple disciplines and consultants – from design, project management and compliance to engineering, finishing and fabrication – using the technologies of today to provide an end-to-end solution that meets all requirements. This synergy has seen Active Metal become the partner of choice on projects from their earliest stages, ensuring the architect's vision for a staircase is soundly brought from concept to creation.

References

[i] Designing Buildings Ltd. "Stair Design." Designing Buildings Wiki. https://www.designingbuildings.co.uk/wiki/Sair_Design (accessed on 17 September 2020).

[ii] Ibid.

[iii] See, e.g. NCC Vol. 1, Specification D1.12.

[iv] International WELL Building Institute. "WELL Building Standard®." IWBI. https://standard.wellcertified.com/well (accessed on 17 September 2020).

[v] International WELL Building Institute. "Feature 64: Interior Fitness Circulation." IWBI https://standard.wellcertified.com/fitness/interior-fitness-circulation (accessed on 17 September 2020).