Riser height tolerances on very wide concrete stairs

The NCC, construction tolerances and the evidence on stair safety

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This paper provides general information only. It is not legal advice and is not a compliance assessment of any particular building, including any stair used as illustrative context. Readers should obtain advice specific to their circumstances and check the current text of the National Construction Code and the referenced standards before relying on any statement in this paper. Recommendations labelled Suggested go beyond the minimum requirements of the NCC and are the author's professional suggestions.

Abstract

Very wide in-situ concrete feature stairs, often more than 7 m wide, are common at the entries of Australian shopping centres. NCC 2022 Volume One D3D14(1)(c) requires goings and risers to be constant in each flight, and deems them constant when adjacent risers differ by no more than 5 mm and the largest and smallest risers in a flight by no more than 10 mm. This paper examines that rule for a non-required feature stair in a Class 6 shopping centre. It uses a typical wide external in-situ concrete feature stair as illustrative context only. It separates what the NCC says from interpretation, compares Australian, United States, New Zealand and United Kingdom provisions, and reviews research on stair gait, foot clearance, perception of small dimensional changes and stair-fall injury.

The paper identifies a construction-tolerance gap that matters most for very wide stairs. Concrete flatness is usually specified with a 3 m straightedge, which controls local undulation but not the level of a 7 m nosing. Two nosings can each pass a straightedge check and still produce risers that fail D3D14 near the ends of the stair, and the NCC does not say where across the width a riser is measured. The paper ends with practical guidance on survey, acceptance criteria and remediation. Recommendations that go beyond the NCC are labelled Suggested.

Keywords: stair safety; riser height; dimensional uniformity; construction tolerance; NCC D3D14; concrete flatness; gait; foot clearance; falls; access consulting.

1 Introduction

1.1 Background

Stairs are an everyday but disproportionately hazardous part of the built environment. Jacobs (2016, p. 159) summarises the literature: "stairways are a common location for falls, and they result in a disproportionate risk of death or severe injury". The ABCB states that the D3D14 going and riser requirements "date from a substantial reform carried out in 1987, based on international research" (ABCB n.d.a). Less attention has gone to whether a stair as built matches its design. For in-situ concrete this matters most, because each riser is the difference between two independently formed and finished surfaces.

Very wide feature stairs add problems: side handrails are out of reach for most of the width, crowds use the whole flight and uniform concrete can disguise step edges. Above all, a riser that is 7 m long has many more opportunities to vary than one that is 1.2 m long. This paper asks a practical question that certifiers, builders and designers face. What is the maximum riser variation the NCC allows in a very wide public stair in a shopping centre, and is that enough?

1.2 Subject stair and scope

The discussion uses, as illustrative context, a wide external in-situ concrete feature stair of the kind often built at the entries of Class 6 shopping centres. This paper treats such a stair as a non-required stairway. That is, it is not relied on as a required exit. It serves a Class 6 building to which the public have access. No survey data for any particular stair have been relied on. The hypothetical numerical examples in this paper do not determine whether any stair complies, and the paper makes no finding about the compliance of any particular stair.

The following features are typical of such stairs:

- a very wide external in-situ concrete stair;
- several intermediate stainless steel handrails dividing the width;
- dark contrasting nosing strips on every tread;
- tactile ground surface indicators (TGSIs) on the top landing;
- balustrades with handrails on both sides; and
- a long flight, apparently of about ten or more risers before a landing.

A stair of this kind often has a mid landing and therefore two flights. Section 2.4 discusses what D3D14 means for a two-flight stair, separately from a hypothetical numerical example used there to illustrate the flight tests, and section 7 sets out how a stair of this kind could be tested.

The scope is the NCC Deemed-to-Satisfy (DtS) Provisions for a non-required stairway in a Class 6 building, together with the referenced access provisions. The width-counting rule in D3D10 applies only to required stairways and is outside the scope of this paper.

1.3 Method and conventions

NCC clauses were read on NCC Online (ABCB 2022; ABCB 2025a). Explanatory material was read in the ABCB Guide to Volume One and the ABCB Housing Provisions (ABCB n.d.a; ABCB 2025b). International provisions were read in their published or publicly hosted form where available. Research sources were limited to papers and reports whose text or abstract was located and read. Where a figure or provision could not be checked against its primary source, the text says so.

Australian Standards were consulted first. AS 1428.1-2009 (incorporating Amendment 1) and AS 1428.1:2021 were read in licensed copies held by the author. The author's licensed copy of AS 1657:2018 is in a protected format whose text could not be searched. AS 3600, AS 3610.1 and AS 3727 were not available, so their values were taken only from lawful public sources that reproduce them, such as CCAA and government publications. Second-hand values are identified as such, and values that could not be confirmed are flagged for verification. Unauthorised copies of standards found online were not used. Quoted NCC wording is reproduced exactly. Statements of interpretation are identified as such. Recommendations that go beyond the NCC are introduced with the word Suggested.

2 The Australian regulatory framework

2.1 Which edition applies

NSW currently applies NCC 2022 Volume One as amended by Amendment 2. Amendment 2 took effect on 29 July 2025, and its main change was to reference the 2021 edition of AS 1428.1 (ABCB 2025c). According to the ABCB adoption table, NSW will adopt NCC 2025 on 1 May 2027 (ABCB 2026). The text of D3D14 quoted below is the same in NCC 2022 and NCC 2025 (ABCB 2022; ABCB 2025a). The 5 mm and 10 mm tolerances are not new. They appear in the same form in D2.13(a)(iii) of NCC 2016 (ABCB 2016).

2.2 The text of D3D14

D3D14(1) provides that "a stairway must have—" a number of features. The relevant limbs, quoted in full from NCC 2022 Volume One (ABCB 2022), are below. The wording of limb (c) was checked verbatim against NCC Online for both NCC 2022 and NCC 2025 on 5 November 2026 and is identical in both. The trailing "and" joins limb (c) to limb (d), which deals with openings in risers.

(a) not more than 18 and not less than 2 risers in each flight; and

(b) going (G), riser (R) and quantity (2R + G) in accordance with Table D3D14, except as permitted by (2) and (3); and

(c) constant goings and risers throughout each flight, except as permitted by (2) and (3), and the dimensions of goings (G) and risers (R) in accordance with (1)(b) are considered constant if the variation between— (i) adjacent risers, or between adjacent goings, is no greater than 5 mm; and (ii) the largest and smallest riser within a flight, or the largest and smallest going within a flight, does not exceed 10 mm; and

For a "public" stairway, Table D3D14 sets riser limits of 115 to 190 mm, going limits of 250 to 355 mm, and a 2R + G quantity of 550 to 700 mm. Table Note 2 states that "going and riser dimensions must be measured in accordance with Figure D3D14". The figure was not reproduced for this paper. Readers

should consult it directly for the measuring convention.

Two features of the drafting matter. First, the tolerance is not a free-standing permission. It defines when dimensions "are considered constant". Constancy is the requirement; the 5 mm and 10 mm figures are the deemed-to-satisfy test of it. Second, both tests must be met. The adjacent test limits the step-to-step change. The range test limits drift along the flight, so risers that each differ from the next by 4 mm but climb steadily will fail once the flight range exceeds 10 mm.

Both tests compare measured risers with each other. Neither refers to the design height, a datum or the level of any nosing. A flight whose risers range from 180 mm to 190 mm, with no adjacent pair more than 5 mm apart, complies: its range is exactly 10 mm, which "does not exceed 10 mm", and 180 mm next to 185 mm is a variation "no greater than 5 mm". A flight built uniformly a few millimetres away from the drawn riser also complies, provided Table D3D14 is met.

2.3 Application to a non-required feature stair

D3D14(1) applies to "a stairway" and is not limited to required stairways. D3D14 itself shows this. Subclause (1)(h) prohibits winders "in the case of a required stairway". Subclause (2) then sets separate rules "in the case of a non-required stairway". Table Note 1 also defines "private" stairways to include, "in any building, stairways which are not part of a required exit and to which the public do not normally have access". A non-required stair in a shopping centre is one to which the public do have access, so the "public" row of Table D3D14 applies to it.

D3D14(2) is the only concession for non-required stairways, and it deals only with winders and goings. It permits "not more than 3 winders in lieu of a quarter landing" or "not more than 6 winders in lieu of a half landing", requires the going of straight treads to be constant on the same 5 mm and 10 mm tests, and lets winder goings differ from straight goings if the winders are themselves constant. It does not relax the riser requirement. A straight, wide, non-required stair with no winders gains nothing from it, and D3D14(1)(c) applies in full. Part D3 describes itself as covering parts of buildings "that are part of an exit", but D3D14 expressly addresses non-required stairways, so in this author's interpretation it governs the subject stair as a DtS requirement.

Other provisions also apply to such a stair.

- D3D22 (handrails) applies to stairways generally, including non-required stairways. Section 2.7 discusses it.
- D4D4(a) applies "in a building required to be accessible". It requires every stairway, except stairways in areas exempted by D4D5, to comply with the stairway clause of AS 1428.1. A Class 6 shopping centre is a building required to be accessible. Under NCC 2022 Amendment 2, D4D4(a)(ii) requires "for a stairway, except a fire-isolated stairway, clause 8 of AS 1428.1" (ABCB 2025c). Before Amendment 2, the reference was to clause 11 of the 2009 edition (ABCB 2022).
- D4D9 requires TGSIs "to warn people who are blind or have a vision impairment that they are approaching— (a) a stairway, other than a fire-isolated stairway" (ABCB 2025a).
- D3D14(1)(e) requires slip-resistant treads or nosing strips classified in accordance with AS 4586, which is relevant to any remediation by grinding or by new nosing strips.

2.4 Flights, landings and the subject stair

Both tests in D3D14(1)(c) refer to a flight: constancy "throughout each flight" and the range "within a flight". Schedule 1 defines a flight as follows. The wording was checked verbatim on NCC Online on 5 November 2026 and is the same in NCC 2022 and NCC 2025 (ABCB 2022; ABCB 2025a):

Flight: That part of a stair that has a continuous series of risers, including risers of winders, not interrupted by a landing or floor.

A landing is "an area at the top or bottom of a flight or between two flights". A riser is "the height between consecutive treads and between each landing and continuous tread". Under these definitions a mid landing ends one flight and starts another. Nothing in D3D14 requires the risers of the upper flight to match those of the lower flight. Each flight is tested separately against the 5 mm and 10 mm limits, and each riser must also stay within Table D3D14. Nor are the last riser of one flight and the first of the next "adjacent risers" within a flight, because the landing interrupts the series.

The explanatory information adds that a flight "has a continuous slope created by the nosing line of treads" and that its length "is limited to restrict the distance a person could fall down a stair" (ABCB 2022). It says nothing about the rise of one flight compared with the next.

A hypothetical two-flight stair shows the effect. Suppose that one flight varies between 180 mm and 190 mm with no adjacent pair more than 5 mm apart, and that the other flight is a uniform 176 mm. These figures are a proposition to illustrate the tests. They are not measurements of any particular stair, and they support no finding about the compliance of any stair. In that example, each flight would pass both tests (ranges of 10 mm and nil), and every riser would be within the 190 mm maximum, so the example would comply with D3D14(1)(c). A user crossing the landing would meet a change of 4 mm to 14 mm between any riser in the 180–190 mm flight and the 176 mm flight. That span follows from the assumed heights themselves (190 mm − 176 mm, and 180 mm − 176 mm); a mean difference is not implied, because a range alone does not establish a mean. Whether the change matters is a human-factors question (section 4.5). Any limit on it is Suggested good practice, not an NCC requirement.

An ABCB presenter said in a 2017 seminar that a riser outside a flight "can be a different riser height to the adjacent flights", while recommending consistency "the whole way through" (ABCB 2017).

A reported variation of 5 mm can be read against D3D14(1)(c) in three ways, depending on what the figure describes. None of the following is a finding that any particular stair complies or fails.

- If 5 mm is the largest difference between adjacent risers within a flight: the adjacent-riser test is met, but only just, because the clause permits a variation "no greater than 5 mm". The range test is a separate check and is not answered by this figure. A flight in which several adjacent differences of up to 5 mm run in the same direction could exceed the 10 mm range. Both flights must be checked against the range test separately.
- If 5 mm is the overall range within each flight: both tests are met in that flight, because no adjacent difference can exceed the flight range.
- If 5 mm was measured at one position across the width only: the result says nothing about the other positions. Section 2.6 discusses this.

A difference in average riser height between two flights does not of itself breach D3D14, whatever its size, provided each flight passes on its own. The research reviewed in section 4.5 suggests, however, that a change in rise at a mid landing deserves attention as a matter of safety rather than compliance. Section 7 suggests how to deal with it.

2.5 ABCB explanatory material

The ABCB Guide to Volume One explains the purpose of the provision. It is "to achieve constant going and riser dimensions deemed safe for people to walk up and down". This "minimises the risk of people overstepping during descent on uneven stairs (due to short goings) and tripping on ascent (due to high risers)" (ABCB n.d.a). The Guide explains that D3D14(1)(c) "accounts for conditions such as movement of materials due to atmospheric moisture changes or minor deviations related to variations in materials which affect finished stair dimensions". It concludes:

Despite the deviations shown in both Figure D3D14a and Figure D3D14b, the stairs in the flight are deemed constant. Irrespective of any minor deviations permitted by D3D14(1)(c) and (2)(b), finished going and riser dimensions must not exceed the limitations stipulated in Table D3D14.

The Guide also states that "more than one riser is considered necessary for a person to observe and adjust to a change in level" (ABCB n.d.a), a point taken up in section 4.

Clause 11.2.2(1)(c) of the ABCB Housing Provisions applies the same 5 mm and 10 mm tests to houses, worded "not more than" (ABCB 2025b).

2.6 What the NCC does not say

The following matters are not addressed by D3D14 or its explanatory material. They are stated plainly because they are often assumed.

- Where across the width a riser is measured. D3D14 gives measuring positions only for tapered treads in curved or spiral stairs: 270 mm in from the side, or from each side where the stair is 1 m wide or more (Table D3D14, Note 3). For a straight stair, the NCC does not say whether a riser is measured at the centreline, at the walking lines, at the handrails or along its whole length.
- Variation along a single riser. The 5 mm and 10 mm tests compare one riser with another. They do not expressly limit how much a single riser may vary from one end to the other. The only provision that contemplates a riser varying across the width is D3D14(3). Where a stairway discharges to a sloping public walkway or public road, "the riser (R) may be reduced to account for the slope of the walkway or road; and the quantity (2R+G) may vary at that location". This narrow exception suggests that other risers are not intended to vary across the width.
- Tread slope or crossfall. D3D14 sets no limit on the slope of a tread in either direction.
- A survey method or acceptance procedure. The NCC does not say how compliance with D3D14(1)(c) is to be demonstrated on site.

In this author's interpretation, the better reading is that the requirement for "constant goings and risers" applies to each riser wherever along its length a person may step. On a stair whose whole width is open to use, a riser that complies at the centreline but not near one end does not fully meet D3D14(1)(c). This is an interpretation, not settled law. No Australian decision found for this paper decides the point.

2.7 Handrails and access provisions for a very wide stair

D3D22(1) requires handrails to "(a) be located along at least one side of the ramp or flight; and (b) be located along each side if the total width of the stairway or ramp is 2 m or more". Except in specified school and early childhood cases, they must be fixed at not less than 865 mm. They must also "be continuous between stair flight landings and have no obstruction on or above them that will tend to break a hand-hold" (ABCB 2025a). D3D22(1)(f) applies clause 9 of AS 1428.1 only "in a required exit serving an area required to be accessible" (ABCB 2025c). It does not reach a non-required stair through D3D22. The access requirements reach that stair through D4D4 instead.

The NCC contains no requirement for intermediate handrails on a wide stair, however wide. The ABCB Guide to D3D22 refers readers to D3D10 for intermediate handrails (ABCB n.d.b). D3D10 is a width-counting rule for required stairways and is outside the scope of this paper. For a non-required stair more than 7 m wide, the DtS Provisions require handrails at both sides only.

Intermediate handrails on a very wide stair are therefore a design decision beyond the DtS minimum, consistent with the research and practice discussed in section 6. Clause 8 of AS 1428.1:2021, applied through D4D4, governs the stair's risers, nosings and handrails (Standards Australia 2021). It requires opaque risers (8.1(c)), defined nosing profiles (8.1(e)) and on each tread a single contrasting strip 50 to 75 mm deep, set back no more than 15 mm, with "a minimum luminance contrast of 30 %" (8.1(f)). Handrails must be on both sides (8.2(b)), with a handrail height "Construction tolerance of up to 10 mm" (9(e)(iii)). None of these provisions sets a riser tolerance. Whether each intermediate handrail must comply with AS 1428.1 in full should be confirmed for each project.

2.8 Australian Standards and other construction benchmarks

No Australian Standard or published Australian benchmark found for this paper sets a tolerance for variation along a single riser or nosing line. Australian Standards are discussed first. The NSW Guide to Standards and Tolerances follows as secondary, non-binding guidance. The concrete flatness and level values are compared in Table 2 (section 7.1).

AS 1428.1. Neither edition sets a riser tolerance. Clause 4.2 of the 2021 edition sets construction tolerances at abutting surfaces of "0 ± 3 mm vertical", or "0 ± 5 mm, provided the higher edge is bevelled or rounded" (Standards Australia 2021). Clause 7.2 of the 2009 edition is to the same effect (Standards Australia 2009). Section 2 of the 2021 edition adds: "Dimensioning to the limit of a range is likely to lead to nonconformities. Good practice in design and documentation aims to allow building tolerances" (Standards Australia 2021, p. 5).

AS 1657. AS 1657 covers industrial stairways and does not apply to a public shopping centre stair, but the experts in Loose Fit treated its tolerance as good building practice (section 2.9). Clause 7.2.3.2 of the 2013 edition, as reproduced by a stair supplier, states: "All risers and all goings in the same flight of stairs shall be of uniform dimensions within a tolerance of ±5 mm" (SR Equipment n.d.). SafeWork NSW (n.d.) gives the same tolerance, based on the 2018 edition. The 2018 wording should be verified against the standard.

AS 3600 and AS 3610.1. CCAA notes that AS 3600 tolerances "relate to the size and position of concrete elements to ensure that the safety factors for the structural design of the elements are maintained" (CCAA 2026, p. 4). Clause 17.5.2.4 of the 2009 edition, as quoted by the WA Building Commission (2013), limits the deviation of any point "from a straight line joining any two points on the surface" to "1/250 times the

length of the line". That is 12 mm over 3 m and 28 mm over 7 m. AS 3610.1 deals with the finish of formed surfaces, not position (CCAA 2026, p. 4). Both standards are cited here second-hand. The clause numbers and values in their current editions require verification.

NATSPEC and other standards. A council edition of the NATSPEC concrete worksection sets flatness Classes A, B and C for unformed surfaces (Muswellbrook Shire Council 2012, cl. 1.6), and CCAA (2026, p. 5) reports a later version. AS 3727 was not located in any lawful public source. AS 2870, according to CCAA, "generally requires concrete work to be in accordance with AS3600" (CCAA 2026, p. 6). AS 4586 classifies slip resistance, which matters for remediation because D3D14(1)(e) requires classified treads or nosing strips.

NSW Guide to Standards and Tolerances 2017. The NSW Guide is the closest NSW published benchmark for straightedge-type floor tolerances, but its scope is limited. It "has been developed for builders and building owners", is "applicable to home building contracts" (NSW Fair Trading 2017, pp. 8–9) and "is only a guide and an advisory document. It is not a regulated standard" (NSW Fair Trading 2017, p. 9). It does not bind a Class 6 shopping centre. Four provisions are relevant.

- Section D: "The tolerances in this Guide apply up to and including the length over which each tolerance is stated to apply. It is not intended that tolerances will be interpolated or proportioned to the actual length of building element measured" (NSW Fair Trading 2017, p. 11).
- 2.7 Finished floor levels: levels are defective where "they depart from the documented FFl or RL by more than 40 mm" (NSW Fair Trading 2017, p. 22).
- 2.8 Levelness of concrete floors: "new floors are defective if, within the first 24 months of handover they differ in level by more than 10 mm in any room or area, or more than 4 mm in any 2 m length. The overall deviation of floor level to the entire building footprint shall not exceed 20 mm" (NSW Fair Trading 2017, p. 22).
- 4.6 Treads and risers in timber stairs: after requiring compliance with the BCA, it states: "A tolerance of up to 5 mm consistent throughout the flight of the stairs from the nominated dimensions in the approved documents is considered acceptable. This tolerance shall not be applied to allow for poor construction practice" (NSW Fair Trading 2017, p. 34).

The Guide does not address concrete stairs and says nothing on accumulation beyond section D. Its stair tolerance differs in form from D3D14(1)(c). It measures each riser against the nominated design dimension, whereas D3D14(1)(c) compares measured risers only with each other and has no design-height reference. Read as ±5 mm about the nominated riser, it would allow adjacent risers 5 mm over and 5 mm under, a 10 mm difference that D3D14(1)(c)(i) forbids. Read as a 5 mm band in total, it is tighter than the NCC range test. Either way, the Guide first requires BCA compliance, so the NCC tests govern.

Roys (2025, p. 33) cites BS 5606:1990 as estimating "a typical variation between one step dimension and the same dimension on the adjacent step of 4-6 mm for some construction methods" (not consulted directly). Ordinary construction accuracy is therefore of the same order as the D3D14 limits.

2.9 Australian case law

No Australian court or tribunal decision found for this paper turns on D3D14(1)(c) itself. Two NSW Court of Appeal decisions are nevertheless instructive.

Loose Fit Pty Ltd v Marshbaum [2011] NSWCA 372 concerned a fall on the upper flight of a concrete stair, later clad in timber, in a small shopping centre in Mosman. The measured risers of that flight were "143, 183, 167, 170, 176, 170, 174, 167, 172, 163, 167 and 157" mm (at [35]). The experts agreed that the variation "exceeds the tolerance of 5 mm specified in AS 1657-1992", that the stair "had dimensional inconsistencies which were capable of disrupting gait", and that the AS 1657 tolerance is "regarded as establishing good building practice for staircase construction generally" (at [39]). One expert noted that such discrepancies "are unlikely to be sufficiently apparent to be visually obvious to the user" (at [40]). Liability turned on the absence of a handrail, and the Court of Appeal ordered the owners to contribute 50 per cent of the damages (at [106]).

Wilkinson v Law Courts Ltd [2001] NSWCA 196 concerned a fall on the broad external steps of the Law Courts building in Sydney, which had "no hand-rail, edge-delineation strips nor warning signs". The Court found no error in the trial judge's conclusions about "the lack of negligence resulting from varying rise heights of the steps". These passages are taken from a case database (Zoe Law n.d.) and the judgment should be read in full before reliance. Wilkinson predates the Civil Liability Act 2002 (NSW). Negligence depends on the facts of each case and is a different question from NCC compliance.

Together, these cases show that small riser irregularities are hard for users to see and are taken seriously by experts. They also show that the outcome of a claim turns on the facts, including the presence of handrails. Neither case establishes a numerical standard beyond the 5 mm tolerance accepted by the experts in Loose Fit.

2.10 Answer to the headline question

The maximum riser variation the NCC allows in a very wide (>7 m) public stair in a shopping centre is set by D3D14(1)(c). It is the same for every stair to which that clause applies, whether required or non-required and whatever its width. Within each flight:

- adjacent risers may differ by no more than 5 mm; and
- the largest and smallest risers may differ by no more than 10 mm; and
- every riser must remain within 115 to 190 mm, with 2R + G within 550 to 700 mm (Table D3D14, public stairways).

Both tests compare measured risers with each other, not with the design height, and apply to each flight separately.

The NCC has no special tolerance for wide stairs. It does not say where across the width a riser is measured. It does not expressly limit variation along a single riser, and it does not require risers in separate flights to match. Section 7 deals with each of those gaps by way of Suggested good practice.

3 International comparison

The provisions below were compared on four questions: whether a numerical tolerance is stated, whether adjacent steps and whole flights are both controlled, where across the width the dimension is measured, and whether consistency is required between flights. Table 1 summarises the results and states whether each provision was verified against its published text.

Table 1: Comparison of riser uniformity provisions

Document	Requirement and tolerance	Width position; between flights	Status
NCC 2022 / NCC 2025 Vol One D3D14(1)(c) (Australia)	Constant goings and risers in each flight. Adjacent ≤ 5 mm; largest − smallest in flight ≤ 10 mm.	Not stated for straight stairs. Per flight only.	Verified
ABCB Housing Provisions 11.2.2(1)(c) (Australia)	Same 5 mm and 10 mm tests ("not more than").	Not stated. Per flight only.	Verified
AS 1657 cl. 7.2.3.2 (Australia, industrial stairs)	"All risers and all goings in the same flight of stairs shall be of uniform dimensions within a tolerance of ±5 mm" (2013 edition, as reproduced).	Not stated. Per flight.	Second-hand; verify 2018 text
IBC 1011.5.4 (USA)	Treads and risers "of uniform size and shape". Largest − smallest riser in any flight ≤ 3/8 in (9.5 mm). No separate adjacent limit in the clause.	Not stated. 1011.5.4.1 allows a non-uniform top or bottom riser at a sloping public way, varying by no more than 1 in 12 of stair width, with a distinctive marking stripe. Per flight.	Text verified (UpCodes); edition not confirmed
IBC 1014.9 (USA)	Intermediate handrails so that all of the minimum width or required capacity is "within 30 inches (762 mm) of a handrail".	Not applicable.	Text verified (UpCodes); edition not confirmed
ACI 117-10 cl. 4.7.1 (USA, concrete construction)	Largest − smallest tread or riser in any flight ≤ 3/8 in (9.5 mm). Adjacent risers "measured at the nose" ≤ 3/16 in (4.8 mm).	Measured "along a line parallel to the stair axis"; position across the width not stated. Per flight.	Verified (publicly hosted copy); later edition not checked
NFPA 101 7.2.2.3.6 (USA)	Reported: adjacent ≤ 3/16 in (4.8 mm); largest − smallest in flight ≤ 3/8 in (9.5 mm).	Not checked.	Secondary sources only; verify
ICC A117.1 504.2 (USA)	Reported: uniform riser heights and tread depths.	Not checked.	Secondary sources only; verify
NZ D1/AS1 4.1.3 (New Zealand)	Riser height and tread depth "for all steps in one flight, shall be uniform within the tolerance of ± 5 mm".	"Measured at the centreline on straight flights". Where ground slopes across the width, the rise is "measured at mid-width" (4.1.2). Per flight.	Verified
Approved Document K para 1.5 (England)	"Level treads on steps, ensuring that the rise and going of each step are consistent throughout a flight of steps". No numerical tolerance.	Not stated. Per flight.	Verified
BS 5395-1:2010 (UK)	Consistency required (reported). No numerical tolerance located.	Not checked.	Not verified
ISO 21542:2021	Consistent rise and going (reported). No numerical tolerance located.	Not checked.	Not verified
NBS BSS 120 guideline 2.2.1 (USA, 1979)	Highlight every nosing if any riser differs from another in the flight by > 1/2 in, from an adjacent riser by > 1/4 in, or varies by > 1/4 in across the width. Consider redesigning or replacing the flight above 1 in.	Expressly addresses variation across the width of a single riser.	Verified (research guideline, not regulation)

Three points emerge. First, the Australian limits are numerically close to the United States limits. The 10 mm Australian range compares with 9.5 mm in the IBC. The 5 mm Australian adjacent limit is slightly looser than the 3/16 in (4.8 mm) adjacent limit in ACI 117-10 and the same figure reported for NFPA 101. ACI 117, a concrete construction standard, adopts the same order of tolerance, measured "along a line

parallel to the stair axis" (American Concrete Institute 2010, cl. 4.7.1). The NZ "± 5 mm" formulation is ambiguous. Read literally as a band about a nominal value, it would permit a 10 mm spread, which matches the Australian range. Read as a limit on difference, it would be tighter.

Second, only New Zealand states where on a straight flight the dimension is measured: at the centreline. Only the 1979 NBS guidelines address variation across the width of an individual riser, and they treat more than 1/4 in (about 6.4 mm) as requiring remedial highlighting (Archea, Collins & Stahl 1979). The IBC allows across-width variation only for the end riser at a sloping public way, and then requires a marking stripe.

Third, every provision located applies its uniformity test within a flight. None of the codes checked requires the risers of separate flights to match. The only statements found in favour of consistency across flights are advisory: the ABCB presenter's recommendation quoted in section 2.4 and the research discussed in section 4.5.

England's Approved Document K has no numerical tolerance. A report for the UK Government by Roys (2025, p. 37) considered whether one should be introduced. It concluded that "any allowance in step variance is therefore likely to increase the risk of a fall in either ascent or descent, compared to a stair with no variance in dimensions". He discussed a tolerance of about ±1 per cent, or ±2 mm on a 200 mm rise, considerably tighter than the Australian rule.

4 Human gait, perception and the margin for error

4.1 The demands of stair use

Stair negotiation is a demanding motor task. Startzell et al. (2000, p. 567) describe it as "among the most challenging and hazardous activities of daily living for older individuals", noting that it relies on somatosensory, visual and vestibular input, much of which declines with age. Jacobs (2016) concludes that "current stair design does not offer an optimal universal design to meet the needs of older adults or people with health conditions". A shopping centre stair is used by the whole population, including older people, children, people carrying goods and people distracted by their surroundings.

4.2 How small the clearances are

Riser variations of a few millimetres matter because the clearances involved are themselves only a few millimetres. In a study of foot clearance during stair descent, Hamel et al. (2005, p. 135) found that older adults "had a significantly larger number of minimum foot clearances which fell below 5 mm" than young adults. Young adults "increased their minimum clearance by 3.6 mm on average in response to a decrease in ambient lighting", but "the older adults maintained the same clearance". Simoneau et al. (1991) found in 36 women aged 55 to 70 that "clearance between the foot and the stair during swing phase was small under all visual conditions".

The New Zealand Acceptable Solution states the same point plainly in its commentary on uniformity: "The foot is normally only lifted a few mm above the treads during ascent. A minor variation in riser height can cause someone to stumble" (MBIE 2017, cl. 4.1.3 comment). The expert evidence accepted in Loose Fit was to the same effect (see section 2.9). When the margin between the foot and the nosing is often only a few millimetres, a riser that is unexpectedly 5 mm higher can use up all of it.

4.3 Calibration on the first steps

Stair users do not measure each step as they go. Summarising the research of the 1970s, including videotape studies, the NBS guidelines state that the perceptual cues for successful stair use "include visual perception of the approach to, and use of the first step, and tactile-kinesthetic perception during the remainder of the flight" (Archea, Collins & Stahl 1979). Whether a person "actually looks at the stair during the critical first steps appears to be the most powerful discriminator between successful and unsuccessful uses": "more than half of the stair users who had missteps did not look at the stairs as they approached them", whereas "all successful users did look" (Archea, Collins & Stahl 1979).

This model explains why non-uniformity is dangerous. The user sets a stepping pattern from the first steps and then relies on it. A riser that departs from the pattern later in the flight will not normally be looked for. The ABCB's explanation that "more than one riser is considered necessary for a person to observe and adjust to a change in level" reflects the same idea (ABCB n.d.a).

4.4 Experimental evidence on inconsistent risers and goings

Francksen et al. (2020) tested the mechanism directly with 26 younger and 33 older adults. They raised one step of an instrumented stair by 10 mm, which increased one rise and reduced the next by 10 mm, a change the authors noted "is not permitted in the UK or USA building regulations" and which would also exceed the Australian 5 mm adjacent limit. Their results were:

- in ascent, "both groups decreased foot clearance (~9 mm) over the inconsistently higher step";
- in descent, "they reduced foot contact length on the higher step by 3%"; and
- these effects occurred "because participants did not alter their foot trajectories, indicating they either did not detect or were not able to adjust to the inconsistent rise" (Francksen et al. 2020, abstract).

A companion study of a 10 mm shorter going found more complex compensation (Francksen et al. 2022). In his report for the UK Government, Roys (2025, p. 36) noted that "the change in rise is not visible in descent and a change in rise is often not detectable visually even in ascent".

No study was found that tests whether a 5 mm variation is detected; applying the 10 mm results to 5 mm is extrapolation. The clearance data in section 4.2 nevertheless suggest that a 5 mm change is a large fraction of the margin available to many users.

4.5 Transitions between flights

A mid landing interrupts the flight and gives the user a chance to recalibrate. On the NBS model, that recalibration is largely visual and occurs at the first steps of the new flight (Archea, Collins & Stahl 1979). The NBS guidelines stress that successful stair use involves "looking down at the stair treads from at least one stride away from the first riser until the completion of the first step on the stair". They warn of the danger of an "orientation edge" at the beginning of a flight, where the user "may find himself attending to the view beyond that edge at precisely the time when he should be looking down".

Johnson and Pauls (2010) identify non-uniformity "at the top of stair flights and, to a lesser extent, at the base of stair flights" as a systemic defect, although within a flight rather than between flights. Roys (2025, p. 36) similarly notes that differences in rise "of 5 mm or more are sometimes found on existing stairs",

particularly "at the top and bottom of flights where the final floor finish has been changed relative to the steps".

No study was found that measures the effect of a change in mean riser height between two flights. The following is the author's reasoning from the sources above, not an established finding. A user descending a long upper flight sets a stepping pattern for its riser height. If the landing is short or crowded, or the user does not look at the first steps of the lower flight, that pattern may carry over to a flight with a different rise, a change Roys describes as "not visible" in descent. The risk is likely to be greatest in descent, in crowds and for users who are not looking at the stair.

Applied to the hypothetical example in section 2.4 (one flight varying between 180 mm and 190 mm, the other a uniform 176 mm), the reasoning runs as follows; it remains the author's inference from assumed heights, not from measurements of any particular stair. A user moving from any riser in the 180–190 mm flight onto the 176 mm flight, or the other way, would meet a change of 4 mm to 14 mm. That span includes changes of the same order as the 10 mm single-step change that participants did not adjust to in section 4.4 (Francksen et al. 2020). A user descending from the taller of those flights would reach each tread of the 176 mm flight sooner than expected. A user moving into the taller flight would meet risers up to 14 mm higher, the situation in which Francksen et al. (2020) found ascent clearance over the higher step reduced by about 9 mm, against the few-millimetre margins in section 4.2. The landing allows recalibration only if users look at the first steps of the new flight, which a short or crowded landing makes less likely. The NCC would accept this change; section 7.6 sets out Suggested good practice.

4.6 Visual cues at the nosing

If small dimensional variations cannot be seen, clear step edges at least help users place their feet accurately. Foster et al. (2014) found that a high-contrast highlighter placed flush with the tread edge improved foot placement and heel clearance, especially with simulated visual impairment. Strips set back from the edge reduced clearance and increased accidental contacts. The NIHR-funded programme reported by Elliott et al. (2015) confirmed the value of flush edge highlighting. It also found that a horizontal–vertical illusion pattern on the risers increased toe clearance in ascent.

The NBS guidelines treat edge visibility as a remedy for irregularity, recommending that "the edge of every tread in the flight" be refinished "with a clearly visible strip of color" where risers vary (Archea, Collins & Stahl 1979). Dark contrasting nosing strips of this kind are this control. AS 1428.1:2021 clause 8.1(f) allows the strip to be set back up to 15 mm (section 2.7), which is worth noting against Foster et al.'s finding that set-back strips reduced clearance.

5 Epidemiology and forensic evidence

5.1 The scale of stair injury

In Australia, the AIHW reports 16,596 hospitalisations in 2024–25 coded to "Fall on and from stairs and steps (W10)" with the sub-category "Unspecified stairs and steps". That is a rate of 60.6 per 100,000 population (AIHW n.d.). This is one sub-category of the W10 code, not the total for all stair and step falls. The total, and the share occurring in shopping centres, were not located for this paper. The AIHW also reports that deaths from falls on stairs and steps "increased among those aged 75 years and over during the past decade".

In the United States, Blazewick et al. (2018) estimated 24,760,843 stair-related injuries treated in emergency departments from 1990 to 2012, or 37.8 per 10,000 residents a year, with the annual rate rising by 24.0 per cent between 1996 and 2012. They concluded that this "underscores the need for increased prevention efforts, particularly those related to stair design and construction". In the United Kingdom, Roys (2001, p. 135) reported that "when exposure is taken into account, stairs are one of the most hazardous locations in buildings".

5.2 Non-uniformity as a cause

The link between irregular dimensions and accidents has been reported for more than four decades. The NBS guidelines report the residential survey by Carson et al. In that survey, "irregularity in riser-tread dimensions was found to be related to increased accident rates for the total sample, though not for the site sample". They conclude that the chief design features related to accidents include "irregularities within a flight" (Archea, Collins & Stahl 1979).

Cohen, LaRue and Cohen (2009) analysed 80 stairway falls investigated for litigation. Sixty per cent of the stairs "were found to have riser variations of greater than 0.375 in." The average riser variation in the investigated cases was "approximately 0.625 in., a full quarter-inch more than the amount of variation allowed by the model codes". About one-third of the stairs where treads were measured exceeded the same criterion for treads. The authors concluded that "excessive dimensional variation appeared to be the most pervasive factor in stairway fall causation". Their explanations for the variations included "natural settling" and "design and construction flaws".

Johnson and Pauls (2010) observe that "non-uniformity has long been identified as a danger". They add that "there have been serious deficiencies in the ways rules are stated and then enforced". Roys (2025, p. 34) writes from experience as a stair expert witness that "most existing stairs that have been investigated post injury, demonstrate measurable inconsistencies in the dimensions on the stair", and that "it is also often the case that the fall appears to have been associated with this inconsistency".

5.3 Gaps in the Australian evidence

The most substantial Australian review located is the study of slips, trips and falls commissioned by the ABCB from the Monash University Accident Research Centre (Ozanne-Smith et al. 2008). It reports that "in Australia stair and step fall injuries increased by over 70 percent during the decade 1993/4 to 2002/3", citing Gunatilaka et al. (2005) (Ozanne-Smith et al. 2008, p. 21). It also quotes the conclusion of Jackson and Cohen (1995) that "the greatest problem with accident stairways is not the individual (i.e. user) or external variables, but dimensional inconsistency inherent in some stairways" (Ozanne-Smith et al. 2008, p. 24). The primary sources it cites were not consulted for this paper.

No Australian dataset was located that links stair falls to measured riser variation. None was located for falls in shopping centres or on wide public stairs. Safe Work Australia data on stair falls were not located. These gaps should be acknowledged in any expert or regulatory use of this paper. The international evidence is consistent, but it comes largely from forensic case series and laboratory studies, not from population studies of public stairs.

6 Issues specific to very wide stairs

6.1 Reach to a handrail

On a stair more than 7 m wide with handrails only at the sides, most users are several metres from a handrail. The NBS guidelines recommended intermediate railings on stairs "wide enough for 3 or more users to ascend side-by-side", "so that every user is within an arm's length of a usable railing", while noting that no causal link with accidents had been established (Archea, Collins & Stahl 1979). IBC 1014.9 now requires intermediate handrails so that the minimum width or required capacity is within 762 mm of a handrail.

As noted in section 2.7, the NCC does not require intermediate handrails. Wilkinson shows that a court may not regard their absence as negligent. In Loose Fit, by contrast, the missing handrail was decisive. Intermediate handrails that divide the width into narrower lanes bring more users within reach of a rail and give a visual line that marks the direction and slope of the flight.

6.2 Crowds, attention and where people walk

Wide stairs at shopping centre entries carry crowds in both directions, and other people can hide the steps ahead. That matters because the NBS work associated missteps with not looking at the stair during the first steps (Archea, Collins & Stahl 1979). Calf Looking (2015) noted a "lack of agreement on the lateral location to make the measurements" and found that users' distance from the handrail "is significantly affected by the direction of travel and by use of the handrail". On a 7 m stair divided by intermediate rails, users in different lanes step on different parts of each riser.

6.3 Visual camouflage

Large areas of uniform concrete can make step edges hard to read. Cohen, LaRue and Cohen (2009) describe "deceptive visual cues, including the presence of expansion joints that blend in with the grooves along the step edges". The NBS guidelines list "high-contrast shadows parallel to tread edges" and "orientation edges" among the visual hazards (Archea, Collins & Stahl 1979). An open view beyond the top of a stair can create an orientation edge. Contrasting nosing strips define each edge and, in the author's view, are the main defence against camouflage on such a stair.

6.4 Why intermediate handrails do not remove the tolerance problem

Intermediate handrails address reach. They do not change the geometry of the risers. In the author's view, a wide stair divided into lanes creates several stairs side by side, each of which must meet D3D14(1)(c). A user in a lane near one end steps on the end portion of each riser. If the risers vary along their length, that user may meet risers that differ from those at the centreline. A centreline survey would not detect that, and because the rails keep users in one lane, any variation is met consistently by users in the affected lane.

For these reasons, a wide stair with good intermediate handrails still needs the measurement approach in section 7. That includes the Suggested test of variation along each riser.

7 The construction-tolerance gap and practical guidance

This section deals with the central practical problem for a stair more than 7 m wide. Concrete flatness tolerances are local. The NCC riser tests are relative. Neither controls how a nosing line behaves over its full length. The section explains why, gives a hypothetical worked example, and then sets out Suggested survey methods, acceptance criteria, specification measures and remediation options.

7.1 How straightedge tolerances work

A straightedge test places a rigid straightedge anywhere on the surface, in any direction, and measures the largest gap beneath it (CCAA 2026, p. 2). It measures flatness, which CCAA defines as "The deviation of the surface from a straight line joining two points on the surface". It does not measure levelness, which CCAA defines separately as "The permitted vertical variation of the surface from a fixed external reference point or datum" (CCAA 2026, p. 2).

Table 2 sets out the straightedge and level tolerances found for this paper. The last column gives the author's reading of what each tolerance would permit along a single 7 m nosing if it were applied to that line. None of these documents was written for stair nosings, so the column is illustrative only.

Table 2: Flatness and level tolerances compared with what they permit along a 7 m nosing

Source	Test and value	Status	Along a 7 m nosing (author's reading)
AS 3600-2009 cl. 17.5.2.4	Deviation from a straight line between any two points ≤ 1/250 of its length (12 mm over 3 m).	As reproduced in WA Building Commission (2013); 2018 text to be verified	Up to 28 mm from a straight line over 7 m. No control of tilt.
CCAA Table 3, slabs (after AS 3600)	12 mm under a 3 m straightedge; surface level within ±10 mm of specified level.	Second-hand (CCAA 2026, p. 7)	Ends may differ by up to 20 mm if one end is +10 mm and the other −10 mm.
CCAA, polished and similar floors	6 mm under 3 m (small areas); 8 mm (larger areas).	Verified (CCAA 2026, p. 6)	No control of tilt.
AS 3610.1 Class 2 (formed surfaces)	Undulations under a 1500 mm straightedge: 3 mm (90 per cent), 6 mm (100 per cent).	As reproduced in CCAA (2026, p. 5); edition to be verified	Applies to formed faces such as risers. No control of tilt.
NATSPEC unformed surfaces	Class A 3 mm under 3 m; Class B 6 mm under 3 m; Class C 6 mm under 600 mm. A later version gives Class A as 4 mm under 2 m.	Verified (Muswellbrook Shire Council 2012); later version per CCAA (2026, p. 5)	No control of tilt.
NSW Guide 2.8 (residential)	4 mm in any 2 m length; 10 mm in any room or area; 20 mm over the footprint.	Verified (NSW Fair Trading 2017, p. 22)	Up to 10 mm end to end if a tread is treated as an "area".
ACI 117-10 cl. 4.8.6.1	Gap under a 10 ft (3.05 m) straightedge. "Flat": 1/4 in (6.4 mm) for 90 per cent, 3/8 in (9.5 mm) for 100 per cent. "Conventional": 1/2 in and 3/4 in.	Verified (American Concrete Institute 2010)	No control of tilt.
BS 8204-2 SR1 / SR2 / SR3	3 mm / 5 mm / 10 mm under a 2 m straightedge.	As reproduced in Concrete Society (n.d.)	No control of tilt.
Concrete Society TR34	Classifies floor flatness by survey.	Not consulted; requires verification	Not assessed.

NCC D3D14(1)(c)(i) (for comparison)	Adjacent risers differ by ≤ 5 mm.	Verified	Compares measured risers with each other at the same position; no design-height reference and no flatness criterion (section 7.3).

7.2 Why a 3 m check does not control a 7 m nosing

There are three geometric reasons why a 3 m straightedge check, however tight, does not control the level of a 7 m nosing.

- Tilt is invisible to a straightedge. A nosing that is perfectly straight but out of level gives no gap under a straightedge. A fall of 1 in 1000 is 7 mm over 7 m and would pass every straightedge class in Table 2.
- Gentle curvature grows with the square of length. For a uniform curve, the gap under a straightedge is proportional to the square of its length. A bow that gives a 1 mm gap under 3 m gives about $1 \times (7/3)^2$, or about 5.4 mm, between the ends and the middle of a 7 m line. A 2 mm gap under 3 m becomes about 11 mm over 7 m.
- Tolerances are not proportioned to length. The NSW Guide states that tolerances "apply up to and including the length over which each tolerance is stated to apply" and are not to be "interpolated or proportioned" (NSW Fair Trading 2017, p. 11). Under a rule of "4 mm in any 2 m length", a nosing could rise steadily by 2 mm per metre. Every 2 m length would comply, yet the nosing would be 14 mm out of level over 7 m. Only the separate limit of 10 mm "in any room or area" would stop it.

The only tolerances in Table 2 that control the ends of a nosing relative to each other are level tolerances: ±10 mm for slabs in the CCAA table and 10 mm per room or area in the NSW Guide. They allow the two ends of one nosing to differ in level by up to 10 mm, and they say nothing about how the level of one nosing relates to the next. Because each riser is the difference between two nosing levels, differences of that order can appear between measured risers at one end of the stair (section 7.3). A builder can therefore meet every concrete tolerance that is usually specified and still build a stair whose risers fail D3D14(1)(c) near one end. This is the key construction-tolerance gap between the concrete standards and D3D14 for very wide stairs.

7.3 How tread and riser deviations combine

A riser height at any point across the width is the difference between the levels of two consecutive nosings (or treads) at that point. Let the measured level of nosing i at a given station be h(i). The riser below that nosing is $r(i) = h(i) - h(i - 1)$. The difference between that riser and the next one up is $r(i + 1) - r(i) = h(i + 1) - 2h(i) + h(i - 1)$. Only measured levels appear: design levels, and any error shared by every nosing in the flight, drop out, matching the clause's lack of a design-height reference. Two consequences follow.

- Relative position matters, not design level. What changes the adjacent-riser difference is how a nosing sits relative to the nosings immediately above and below it at the same station. If a nosing sits d above the straight line joining its two neighbours, the riser below it is d taller and the riser above it d shorter than they would otherwise be, so their difference changes by 2d. Compliance is still decided only by comparing the measured risers with each other, and a nosing well away from its design level has no effect if the nosings around it share the error.

- Opposite trends add along the width. If one nosing falls across the width while the next one up rises, the riser between them grows at one end and shrinks at the other by the sum of both trends. The risers above and below change the other way, so the measured risers diverge most at the ends of the stair, where a centreline survey does not look.

The analysis assumes that a riser is the vertical distance between consecutive nosings or treads at the same station, which should be confirmed against Figure D3D14. Where across the width the riser is measured is a separate gap (section 2.6). In the author's view, on a stair divided into lanes by intermediate handrails, every lane is a walking line, and a riser should comply wherever along its length people are expected to step.

7.4 Worked example (Suggested, hypothetical)

Suggested: the following worked example is hypothetical. It is not survey data from any particular stair. It shows how two nosings that each pass the tightest straightedge tests in Table 2 can produce risers that fail D3D14(1)(c) near the ends of a 7 m stair while complying at the centreline. The checks below apply only the clause's two tests, comparing measured risers with each other at each station. No design height is used.

Consider four consecutive nosings in one flight of a 7 m wide stair, levelled at 1 m stations from 0 m to 7 m. Nosings 3 and 6 are straight and level, and every other nosing lies parallel to them, so every other riser in the flight (including risers 3 and 7) has the same height, R, at every station. Nosing 4 runs from −3 mm to +3 mm relative to a level line; nosing 5 has the opposite trend, from +3 mm to −4 mm. Table 3 gives the measured risers as R plus or minus millimetres and applies both tests to the whole flight at each station. Figure 2 plots them.

Table 3: Hypothetical worked example (Suggested). Nosing levels relative to a level line, and measured risers relative to R (the height of every other riser in the flight), in millimetres

Station (m)	0	1	2	3	4	5	6	7
Nosing 4 level	−3	−2	−1	0	0	+1	+2	+3
Nosing 5 level	+3	+2	+1	0	−1	−2	−3	−4
Risers 3 and 7 (and all others)	R	R	R	R	R	R	R	R
Riser 4 (nosing 3 to 4)	R−3	R−2	R−1	R	R	R+1	R+2	R+3
Riser 5 (nosing 4 to 5)	R+6	R+4	R+2	R	R−1	R−3	R−5	R−7
Riser 6 (nosing 5 to 6)	R−3	R−2	R−1	R	R+1	R+2	R+3	R+4
Test (i): largest adjacent difference (≤ 5)	9	6	3	0	2	5	8	11
Test (ii): largest − smallest in flight (≤ 10)	9	6	3	0	2	5	8	11
D3D14(1)(c) at this station	Fail (i)	Fail (i)	Pass	Pass	Pass	Pass	Fail (i)	Fail (i), (ii)

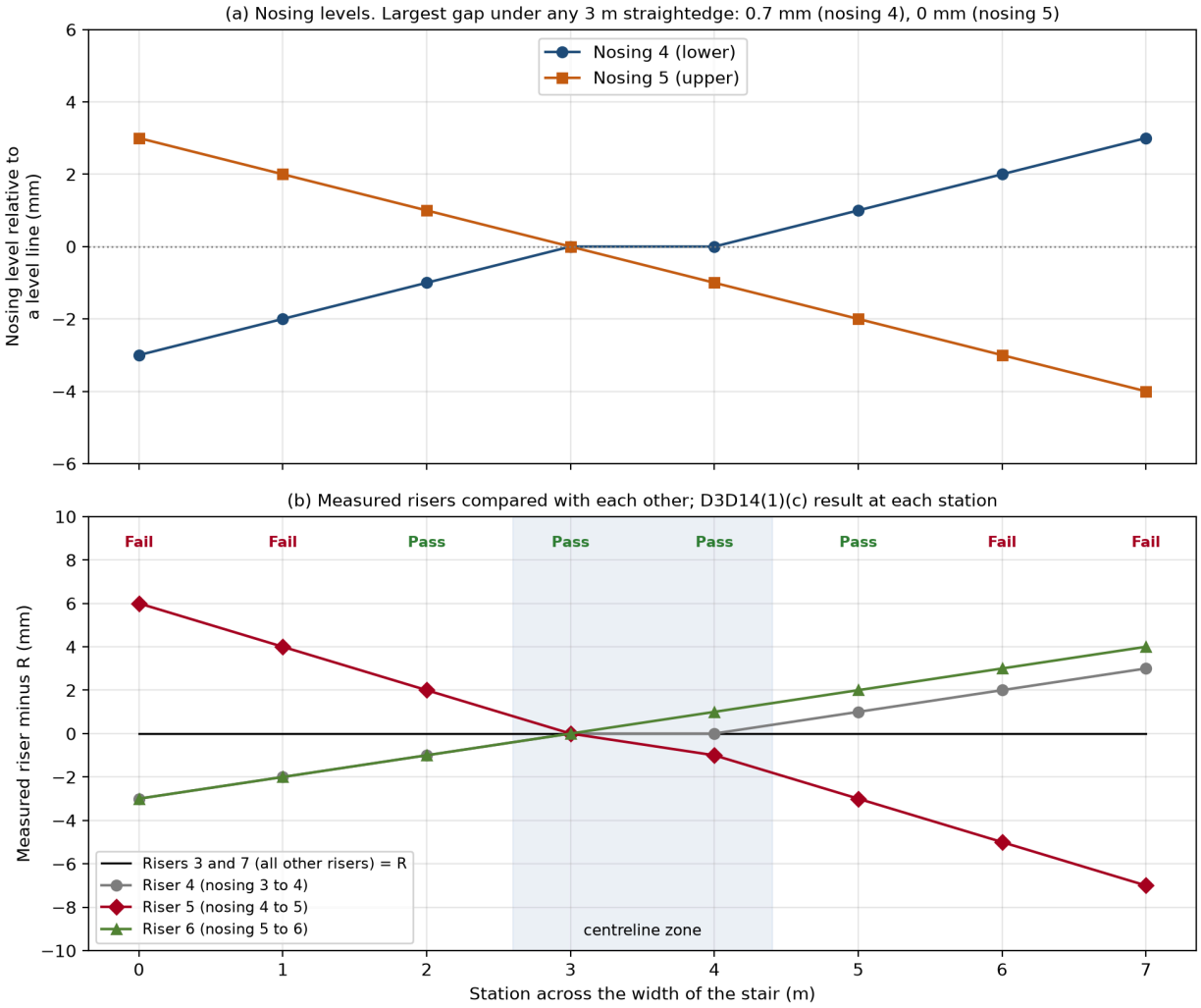


Figure 2: Hypothetical worked example (Suggested). (a) Levels of nosings 4 and 5 relative to level lines across a 7 m width; (b) the resulting measured risers relative to R, the height of every other riser in the flight. Compliance is judged by comparing the risers with each other at each station

The concrete checks all pass. The largest gap under any 3 m straightedge laid along either nosing is 0.7 mm for nosing 4 and nil for nosing 5. That is within NATSPEC Class A, BS 8204 SR1 and every other class in Table 2. No 2 m length of either nosing changes in level by more than 2 mm, which is within the NSW Guide's 4 mm. Each nosing is within 7 mm end to end, which is within the 10 mm "in any room or area" and the CCAA ±10 mm level tolerance.

Applying only the clause's two tests, the stair fails near both ends. Stations 2 to 5, including the centreline, pass, so a centreline survey would report compliance. At stations 0 and 1, risers 4 and 5 differ by 9 mm and 6 mm, failing test (i), though the flight ranges (9 mm and 6 mm) pass test (ii). At station 6, risers 5 and 6 (R − 5 and R + 3) differ by 8 mm, failing test (i). At station 7 they (R − 7 and R + 4) differ by 11 mm, and the flight range is also 11 mm, so both tests fail. None of this depends on R or on the design height. Riser 5 also varies by 13 mm along its length; the NCC has no along-riser test, but that exceeds the Suggested limit of about 5 mm in section 7.6.

In a simpler case, only nosing 4 is out of parallel with the nosings above and below it, rising evenly from 0 mm to +3 mm across the width. At the high end, riser 4 measures R + 3 and riser 5 measures R − 3, so these adjacent risers differ by 6 mm and test (i) fails there, while the flight range of 6 mm passes test (ii).

The tilt is a fall of about 1 in 2300, far inside any straightedge tolerance.

Suggested: use the same survey data to compare the flights either side of a mid landing. In the hypothetical example in section 2.4 (a flight of 180 to 190 mm, then a uniform 176 mm), each flight would comply because the NCC tests flights separately. A user crossing the landing would meet a change of 4 mm to 14 mm from any riser in the first of those flights to the 176 mm flight (section 4.5). Those figures are not measurements of any particular stair.

7.5 Survey method (Suggested)

Suggested: survey each flight of a very wide stair as follows.

- Establish a fixed datum and record nosing levels with a precise level or total station. CCAA notes that optical instruments "can have an accuracy of 0.1mm" (CCAA 2026, p. 2).
- Level every nosing at 1 m centres across the full width. Add points about 300 mm from each end and each side of every intermediate handrail, so that each lane is covered.
- Where the riser is not measured nosing to nosing, also level the tread at the foot of each riser at the same stations, in accordance with Figure D3D14.
- At every station, calculate each riser from the measured levels and apply both D3D14(1)(c) tests per flight, comparing the measured risers with each other rather than with the design height. Also calculate the variation along each riser and the mean riser of each flight.
- Survey at hold points: when the formwork and any nosing angles are set, before the pour; within 72 hours of placement, as CCAA recommends for flatness (CCAA 2026, p. 6); and after finishes, nosing strips and TGSIs are installed. Finishes change finished levels, and the NCC dimensions are measured to the finished surfaces.
- Record the results in a station-by-station table that a certifier can check. A stringline is a useful site check between survey points. CCAA warns that over long horizontal distances "the deflection or 'sag'... could introduce errors" (CCAA 2026, p. 3).

7.6 Acceptance criteria

The minimum acceptance criterion is the NCC: at every station tested, adjacent risers in a flight must differ by no more than 5 mm, the largest and smallest risers in the flight must differ by no more than 10 mm, and every riser must lie within the Table D3D14 limits.

Suggested: for very wide public stairs, add the following criteria.

- Design target. Design every riser in a flight to the same dimension, as an exact division of the floor-to-floor height, and keep well clear of the Table D3D14 limits. AS 1428.1:2021 warns that "Dimensioning to the limit of a range is likely to lead to nonconformities" (Standards Australia 2021, p. 5).
- Testing across the width. Apply the D3D14(1)(c) tests at every survey station across the full width, not only at the centreline.
- Variation along a riser. No single riser should vary by more than about 5 mm along its own length. NBS BSS 120 treated across-width variation of more than 1/4 in (about 6.4 mm) as requiring remedial highlighting (Archea, Collins & Stahl 1979).

- Nosing level. Set nosing level tolerances relative to a fixed datum, not only straightedge tolerances, as a construction control. A nosing level tolerance is not the NCC test and cannot by itself show compliance, because D3D14(1)(c) compares the measured risers with each other (section 7.3). Riser heights must therefore be calculated from the survey and the two tests applied directly.
- Consistency between flights (Suggested good practice, not an NCC requirement). Where two flights are joined by a landing, design them to the same riser height. As a target, treat both flights as one for the 10 mm range test, and keep the difference between their mean riser heights to no more than about 3 mm. The hypothetical example in section 2.4 would comply with the NCC but would miss this target, because treating both assumed flights as one would give a range of 14 mm (190 mm − 176 mm). That comparison does not rely on a mean. Where the means of two real flights differ by more than the target, add the risk controls in section 7.8.

7.7 Specification approach for wide stairs (Suggested)

Suggested: specifications for in-situ concrete stairs wider than about 3 m should include the following.

- A tolerance on each nosing line over the full width, checked by level survey or stringline at 1 m centres, in addition to any straightedge flatness class.
- Riser formwork and screed rails set to level by instrument, not by measurement from the previous step. Step-by-step measurement lets errors accumulate up the flight.
- Cast-in steel or precast nosing angles, set to level by instrument and fixed before the pour, so that the nosing line does not depend on hand finishing. Precast treads are another option.
- Hold points before the pour (formwork and nosing set-out survey), after the pour and after finishes, as in section 7.5.
- A trial or test section for a long nosing. CCAA states that the importance of trial slabs or test panels "can not be over emphasised" (CCAA 2026, p. 9).
- An allowance in the design for the thickness of any finishes, nosing strips and TGSIs, so that finished risers are consistent.

7.8 Remediation and risk controls

CCAA describes several ways of rectifying unformed concrete surfaces (CCAA 2026, p. 9).

- Grinding. CCAA calls grinding "the typical method used" for high spots, warning that appearance and abrasion resistance may be affected. On a stair, grinding the high end of a nosing can reduce variation along a riser, but it changes the riser below as well as the riser above (section 7.3). Slip resistance must then be re-established to satisfy D3D14(1)(e).
- Toppings. CCAA does not recommend localised filling of exposed slabs long-term, but accepts proprietary self-levelling toppings. On a stair, a topping or bonded screed can raise low ends of treads, subject to the nosing details and slip resistance.
- Nosing strips and angles. Replacement nosing strips or angles can be packed to level. Any strip affixed to the tread must comply with AS 1428.1:2021 clause 8.1(f), which refers to Figure 6(a) for the change in level.

- Rebuilding. Where variation is large, recasting the affected treads or nosings may be the only way to comply.

Visual and handrail measures reduce risk, but they do not make non-compliant risers comply. Edge highlighting (section 4.6), intermediate handrails, good lighting and clear sightlines at the head of each flight support the visual check at the first steps (section 4.3).

Suggested: where the mean riser heights of two flights differ by more than about 3 mm and cannot economically be corrected, record the difference and confirm that the nosing strips comply in full. Keep the mid landing free of obstructions so that users can see the first steps of the lower flight. Consider whether the stair should be assessed as a Performance Solution, which is outside the scope of this paper.

8 Conclusions

The NCC sets one riser tolerance for every stair to which D3D14(1)(c) applies. Within each flight, adjacent risers may differ by no more than 5 mm, and the largest and smallest by no more than 10 mm. That rule applies in full to a non-required feature stair in a Class 6 shopping centre, however wide. D3D14(2) relaxes only the rules for winders. The NCC does not require risers in separate flights to match. It does not say where across the width a riser is measured, and it does not expressly limit variation along a single riser. Both tests compare measured risers with each other, not with the design height. For example, a flight of 180 to 190 mm with no adjacent step over 5 mm complies, as does a following flight of a uniform 176 mm. That pairing illustrates the tests; it is not a measurement of any particular stair.

The international codes reviewed use similar limits, also per flight. The research shows why millimetres matter: foot clearances are often only a few millimetres, users calibrate on the first steps, participants did not adjust to a single rise changed by 10 mm, and a forensic series of 80 falls found dimensional variation the most pervasive causal factor. Evidence for a 5 mm effect is inferential.

For very wide in-situ concrete stairs, the main practical risk lies in the gap between concrete tolerances and D3D14. Straightedge tolerances control local flatness, not the level of a 7 m nosing. Because each riser is the difference between two nosing levels, a nosing that tilts relative to its neighbours changes two risers in opposite directions, and the measured risers diverge most at the ends. A stair can meet every flatness class in Table 2, pass at the centreline and still fail near its ends. Intermediate handrails, nosing strips and TGSIs address reach and visibility but do not remove the need to measure the risers across the full width of each flight. Comparing the two flights is Suggested good practice; the NCC does not require it.

Suggested: treat the NCC 5 mm and 10 mm tests as the minimum and apply them at 1 m stations across the full width; limit variation along any riser to about 5 mm; design both flights of a stair to the same riser height; specify nosing lines by level survey, not only by straightedge; and survey at hold points before the pour, after the pour and after finishes.

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