Determination 2016/063

Regarding the compliance of a single inner handrail to a spiral stairway at 158B Lower Flowers Road, Whangamoa, Rai Valley

Summary

This determination considers the compliance of an alternative solution proposing the use of a single handrail on the inner face of a secondary private spiral stairway. The determination discusses the relative angle of the handrail and the pitch line of the stairs, and whether the handrail is graspable and would provide sufficient grip to arrest a fall.

1. The matters to be determined

1.1 This is a determination under Part 3 Subpart 1 of the Building Act 2004[1] ("Act") made under due authorisation by me, John Gardiner, Manager Determinations and Assurance, Ministry of Business, Innovation and Employment ("the Ministry"), for and on behalf of the Chief Executive of the Ministry.

1.2 The parties to the determination are:

- the owners of the house, C Jackson and D Prior ("the applicants")
- Nelson City Council ("the authority"), carrying out its duties as a territorial authority or building consent authority.

1.3 The matter to be determined[2] is whether a single inner handrail to a spiral stairway, will comply with Clause D1Access Routes of the Building Code[3] (First Schedule, Building Regulations 1992).

1.4 In making my decision, I have considered the submissions of the parties and the other evidence in this matter.

1.5 The relevant sections of the Act, clauses of the Building Code, Acceptable Solutions and Standards referred to in this determination, are set out the Appendices.

2. The building work

2.1 The building work considered in this determination consists of the construction of a two-storey house. The main entry to the house is via a deck to an entry lobby on the upper floor. The upper floor comprises an open plan kitchen, dining, lounge area and toilet, with a large deck wrapping around the house. The lower floor comprises two bedrooms, two bathrooms, and a laundry, with a deck wrapping around three elevations.

[1] The Building Act, Building Code, compliance documents, past determinations and guidance documents issued by the Ministry are all available at www.building.govt.nz or by contacting the Ministry on 0800 242 243.
[2] Under section 177(1)(a) of the Act
[3] In this determination, unless otherwise stated, references to sections are to sections of the Act and references to clauses are to clauses of the Building Code.

2.2 The proposed access between the lower floor and upper floor is by means of a pre-cast concrete spiral stair cantilevered from a central column. The plans show the treads at 885mm wide. The tapered precast steps are 230mm deep adjacent the central column, and 460mm deep at the outside edge, with the going respectively approximately 70mm and 400mm. Each precast step rotates 22.5° relative to the step beneath. The pitch line to the stair is stated as 33°57' (which I take to be 34°).

2.3 The stair is enclosed by a circular wall with a diameter more than 2.0m, which extends from the lower floor to 900mm above the upper floor. There are two enlarged "platform landings" with risers of 195mm, leading from the base of the stair to the lower level.

2.4 The drawings show the spiral stairs to have a riser height of both 175 and 185mm, I have taken the riser to be 184mm; being the inter-storey height (3150mm), less the platform landings (2x195mm) and dividing the remaining distance by the number of risers to the spiral stair (15).

2.5 The applicants propose to use a single 40mm diameter handrail located on the inner central column of the spiral stairway on brackets that project away from the column by 125 to 150mm. The applicants advise that the handrail will project past the top riser and will run horizontally for a short distance to provide a 'lead in' to the stairs. The rail to the inner column is to proposed to replace that shown on the consented drawings located at the outside edge of the stair.

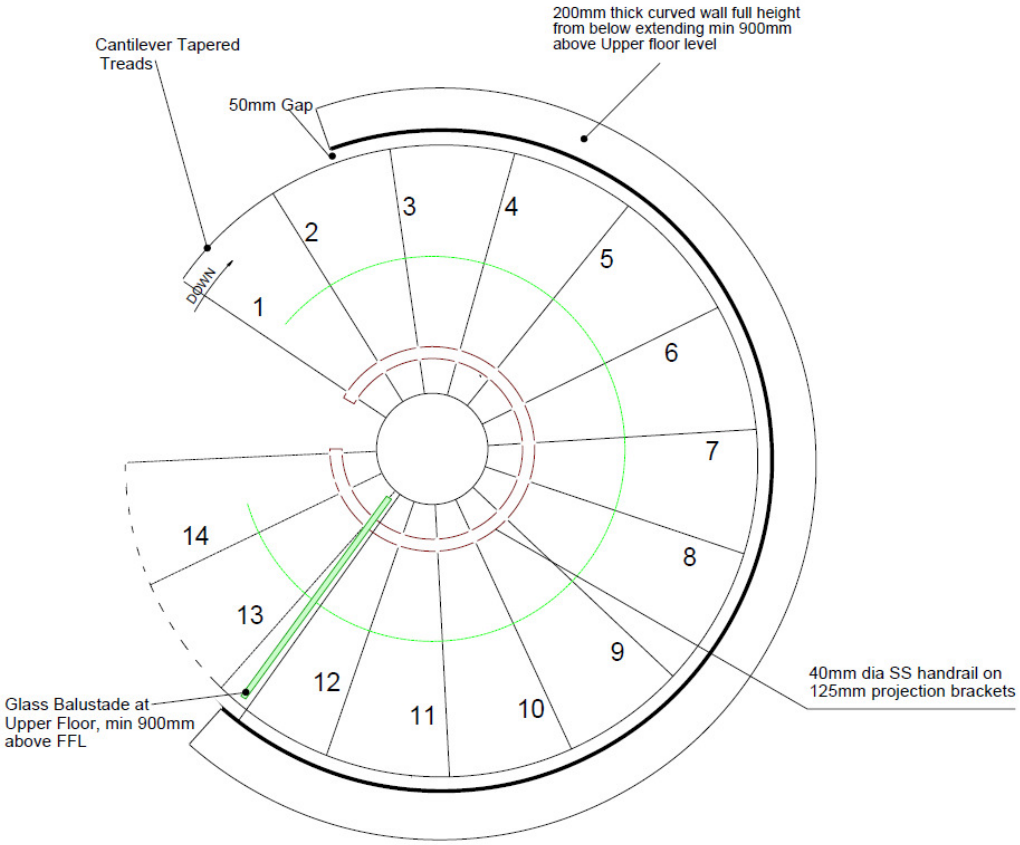


Figure 1: Plan of the spiral stair as proposed (not to scale)

3. Background

3.1 The construction of the house has been carried out under a building consent no. BC050116 issued by the authority on 9 June 2006. I have not seen a copy of the approved plans on which that consent was issued.

3.2 During construction, the applicants sought the authority's view regarding compliance of a single inner handrail for the spiral stairway. By email on 7 July 2016 the authority advised that the handrail would need to be on the outside of the spiral. The authority based this view on Figure 17 of the Acceptable Solution D1/AS1 for curved stairways with tapered treads (refer Appendix A.2), and paragraph 6.0.4 of D1/AS1 which states 'Handrails shall have the same slope as the pitch line'.

3.3 The applicants responded by email on the same day, noting that although Figure 17 of D1/AS1 shows a handrail on the outside, the examples in Figure 18 state that the handrail can be on either side, and one of the examples shows the handrail on the inner face. The applicants were of the view that handrail slope relative to the pitch line could be achieved on either side, and that it was the applicants' intention to project the rail 125 to 150mm into the stair to assist in achieving this.

3.4 The authority emailed the applicants on 8 July 2016, noting that Figure 18 was not a spiral stair, and suggesting the applicants seek a determination on the matter.

3.5 The Ministry received the application for a determination on 3 October 2016.

4. The submissions

4.1 The applicant's submission

4.1.1 In a covering letter dated the 2 October 2010 forwarded with the application, the applicants noted that an officer of the authority had previously accepted the proposed position of the handrail, albeit verbally. The applicants requested the following points be considered (in summary):

- The stair only services three lower floor rooms, two bedrooms and a laundry; the stair should be considered as a "Minor private stairway" as defined in the Acceptable Solution D1/AS1 (refer Appendix A).
- Figures 18 in D1/AS1 states that a tapered tread (winder), less than 1m width, rotating through 90 and 180 degrees may have handrails positioned on either side. This demonstrates the acceptability of handrails on the inside radius of a stair.
- The curved enclosure wall, 'guides and protects users towards the walking/pitch line'.
- Neither United Kingdom nor United States of American building codes/regulations, dictate positioning of the rail, either on the inner or outer walls.
- The United Kingdom Building Regulations, Part K-1.33b state 'if stair is less than 1m wide, provide a handrail on one or both sides' (Refer Appendix B)
- Most falls/ accidents are during descent. With at least 75% of the population being right handed (including the applicants), it is more useful and safer for the rail to be on the inner side.
- 'Optimal handrail heights have been determined between 900-1050mm and will be sited … to allow for and adjust to the easy 34 deg' stair pitch.

- The projecting bracket will guide users onto the wider part of the stairway and provide for 'complete grasp of the rail'. There were several lower floor exits in an emergency.

4.2 The applicants attached copies of:

- floor plans and drawings of the stairway
- photographs of the stairway
- a journal article[4] determining the preferred handrail heights for a spiral stairway (I note the journal article says the handrail heights were taken in respect of an 'outer handrail' only).

4.3 The authority acknowledged the application for determination and provided a submission on 26 October 2016. The authority is of the view the applicants' interpretation of the Acceptable Solution was not correct and could 'create an unsafe situation where a person may not be able to arrest a fall'.

4.4 The authority submitted (in summary):

- It would be impossible for the handrail to be at the same slope as the pitch line as the handrail would effectively be at such a steep slope that it may not arrest a fall.
- The stair should be considered a 'main private stairway' as it provides access to multiple rooms and a large space at the base of the stair.
- If the handrail is on the inside, there is potential for people to enter at the top of the stair perpendicular to the pitch line rather than along the pitch line; this would create an unprotected change in level to the top of the stair of more than a single isolated step[5].
- Figure 18 of D1/AS1 refers to winders, not handrails; the spiral stair does not conform to the features in paragraphs under 4.5 of D1/AS1 relating to winders.
- The applicants' claim that the curved wall will guide and protect users is unsupported, as are the claims regarding the percentage of falls being during decent and there being a greater level of safety for those who are right-handed if it is positioned on the inside.
- Figure 3 of BS 5395: Part 2: 1984 shows two examples of spiral stairs. The example including an inner rail also has handrail on the outside; the example with one rail shows it on the outside. This suggests that the inner handrail can only be used in conjunction with an outer handrail.
- When considering compliance with D1/AS1, paragraph 6.0.4, the pitch line of the stair would need to be considered as being hard up against the central column and the handrail would far exceed the pitch line slope requirements of the Acceptable Solution.
- The article relied on by the applicants was a study based on a single outer handrail at a slope of 30^{o} and therefore does not support the applicants' proposal.

[4] *Preferred handrail height for spiral stairs – a fitting trial study.* J. Sinisammal & P Saaranen. International Journal of Occupational Safety and Ergonomics (JOSE) 2010, Vol 16, No 3, 329-335.

[5] I note here that the authority referenced paragraph 1.3.1 of Acceptable Solution D1/AS1; that paragraph does not apply to household units.

4.5 A draft of this determination was issued to the parties for comment on 28 November 2016. In responses received on 6 and 18 December respectively, the authority and the applicants accepted the draft without further comment.

5. Discussion

5.1 The legislation and the Acceptable Solution

5.1.1 Clause D1.3.3(j) requires that access routes shall:

> Have smooth, reachable and graspable *handrails* to provide support and assist with movement along a stair or ladder,

5.1.2 The Acceptable Solution D1/AS1 is a prescribed means of achieving compliance with the Building Code, though it is not the only means. The applicants submit that Figure 18 of the Acceptable Solution D1/AS1 (refer Appendix A) demonstrates the acceptability of handrails on the inside radius of a stair.

5.1.3 The applicants' submission is, in part, correct. Figure 18 does state that handrails can be on 'either side' of the stair. However, Figure 18 references winders with adjoining straight flights of stairs (refer paragraph 4.5 of D1/AS1). The stairway in this determination is a spiral stairway and therefore, in my opinion, Figure 18 is not applicable and cannot be read as providing for a single handrail to a spiral stair. A spiral stairway is a 'stair describing a helix around a central column'. A spiral stair does not contain a straight flight of steps as shown in Figure 18.

5.1.4 Figure 17(a) of D1/AS describes the location of the pitch line, handrail, and the walking area for spiral stairways of widths less than 1000mm. The handrail in figure 17(a) is shown on the outer edge of the spiral stairway.

5.1.5 The parties have disputed the classification of the stairway under the Acceptable Solution as either a "minor private stairway" or a "main private stairway". The classifications are relevant in terms of the maximum pitch, riser height and minimum tread. I consider the stair a 'main private stairway' being:

> A private stairway intended to provide access to and between frequently used spaces such as living areas, kitchens and garages, and includes all exterior private stairways'.

5.1.6 The classification of the stair is relevant in terms of the slope of the handrail as well as the stair. I note that the maximum pitch given in Table 6 of D1/AS1 for main private stairs is 37^{o}. Paragraph 6.0.4 of D1/AS1 states that 'handrails shall have the same slope as the pitch line'.

5.1.7 The proposed handrail in this case is not in accordance with the Acceptable Solution and must therefore be considered as an alternative solution.

5.2 Compliance as an alternative solution

5.2.1 Considering the proposed alternative solution requires an assessment of the likely performance within the context of this particular house. In evaluating the design, it is useful to make some comparisons with the relevant Acceptable Solutions, which will assist in determining whether a single handrail on the inner face of the spiral stairway is code-compliant.

5.2.2 However, in making this comparison, the following general observations are valid:

- Some Acceptable Solutions cover the worst case, so that they may be modified in less extreme cases and the resulting alternative solution will still comply with the Building Code.
- Usually, when there is non-compliance with one provision of an Acceptable Solution, it will be necessary to add some other provision to compensate for that in order to comply with the Building Code.

5.2.3 Paragraph 4.4.1(a) of D1/AS1 sets of the location of the pitch line for spiral stairways with widths less than 1000mm (see Figure 17, Appendix A). Figure 17 shows the handrail to the outer face of the stair with the pitch line 300mm inside the handrail.

5.2.4 The pitch line of the spiral stairs is stated in the plans as 34°. However, the plans show this 300mm from a handrail located at the outer edge of the stair. If the handrail is to be located on the inner face, as is proposed, then the pitch line for the stair is measured 300mm from the proposed handrail – the pitch line as proposed would therefore be 35°. Irrespective of this, I consider there is a natural tendency to use spiral stairs where the tread is most comfortable to the user: this is at or towards the outside of the stair, not the inside.

5.2.5 With a 150mm projection off the central column to the spiral stair, the inner handrail will have a slope of 54° (see Figure 2). The slope of the consented handrail to the outer edge of the stair is 25°.

5.2.6 The authority has expressed the view that the proposed inner handrail may be so steep that it could not be used to arrest a fall. I accept this position. I note that falls during descent are a major cause of injury, and that use of a handrail lessens the likelihood of a fall and injury[6]; the ability to grip a stair handrail is a key factor in arresting a possible fall.

5.2.7 Clause D1.3.3(j) requires the proposed handrail to be 'reachable and graspable to provide support and assist with movement'. Paragraph 6.0.4 of D1/AS1 states 'handrails shall have the same slope as the pitch line'.

5.2.8 I note here that handrails on either side of a spiral stair will never be at the same slope as the pitch line; the slope of a handrail on the outer face will be shallower, and the slope of a handrail on the inner face will be steeper. The difference will be more pronounced for handrails to the inside of the stair (here 17° steeper) than the outside (9° shallower). The difference disadvantages the user in that the steeper inner handrail is more difficult to grip when descending.

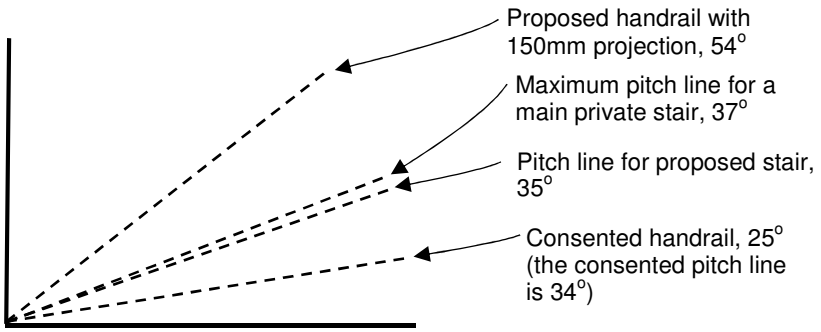


Figure 2: Angle of consented handrail, proposed handrail, and corresponding pitch line

[6] *The staircase: studies of hazards, falls, and safer design*. J.Templer (1994)

5.2.9 The inner handrail, being steeper by 17° than the pitch line, is a significant departure from the Acceptable Solution. The maximum pitch line for this category of stair in the Acceptable Solution is 37° degrees which the spiral stair satisfies – it is noted that the stair satisfies other attributes such as, tread, going, and riser height. However, a usable handrail is an integral component of any stair to assist in ensuring its safe use. While the proposed handrail is of itself the graspable, the angle of the handrail (54°) and the high relative angle of the handrail to the pitch of the stair (17°) in my view means the handrail is not 'graspable to provide support and assist with movement'.

5.2.10 The applicants have referred to overseas regulations and standards (refer Appendix B). I acknowledge that neither the United Kingdom Building Regulations or the International Code Council Building Code dictate that a single handrail must be on the outside of a spiral stairway rather than on the inside face. However, none of the standards contemplate the use of a single handrail to the inside of a spiral stair as the only handrail, and it cannot be inferred that a single handrail on the inside face is compliant with those codes and regulations. The study on optimum handrail heights to spiral stairs referred to by the applicants (at paragraph 4.2, 3rd bullet point) was also conducted on respect of a handrail to the outside of the stair only.

5.2.11 I note that in the commentary included in paragraph 4.1 of BS5395-1:2010[7], which applies in respect of stairs with straight flights and winders, it says

> The need for a handrail on both sides of the stair comes from two sources. Firstly, to allow uses a choice of support when ascending and descending stairs, it is preferable to have a handrail on both sides. … The other reason is that having two handrails reduces the chances of a serious incident happening on a stair.
>
> Every stair should have two continuous handrails, one on each side of the stair, to provide guidance and support to those using the stair. …
>
> Hand rails should: … c) be fixed parallel to the pitch line over steps, or horizontal over landings; …

5.3 Conclusions

5.3.1 The proposed inner handrail is a significant departure from the solutions described in D1/AS1. In my view the angle of the proposed handrail and the high relative angle of the handrail to the pitch of the stair means the handrail does not satisfy the requirements of Clause D1.

6. The decision

6.1 In accordance with section 188 of the Building Act 2004, I hereby determine that the proposed handrail to the inner face of the spiral stairs in this case does not comply with Clause D1.3.3(j) of the Building Code.

Signed for and on behalf of the Chief Executive of the Ministry of Business, Innovation and Employment on 22 December 2016.

John Gardiner
Manager Determinations and Assurance

[7] BS5395-1:2010 Code of practice for design of stairs with straight flights and winders

Appendix A: The Building Code and the Acceptable Solution

A.1 The relevant provisions of Building Code Clause D1 - Access routes, include:

D1.3.3 Access routes shall:

(j) have smooth, reachable and graspable *handrails* to provide support and to assist with movement along a stair or ladder

A.2 The relevant paragraphs and figures from Acceptable Solution for Clause D1 Access, D1/AS1, include:

Definitions

Handrail

A rail to provide support to, or assist with the movement of a person.

Minor private stairway

A private stairway not on a main thoroughfare, and intended to provide infrequent access to a single room which is not a living area or kitchen.

Pitch line

The line joining the leading edge or nosings (if any) of successive stair treads within a single flight of a stairway.

Private stairway

A stairway used, or intended to be used, by the occupants of a single household unit.

Secondary private stairway

A private stairway other than a main or minor private stairway, intended to provide access to another floor containing only bedrooms, bathroom or similar accommodation

Commentary to 1.7 Barriers

Comment:

… A handrail is a graspable rail designed to guide and support people using a stairway or ramp. …

6.0 Handrails

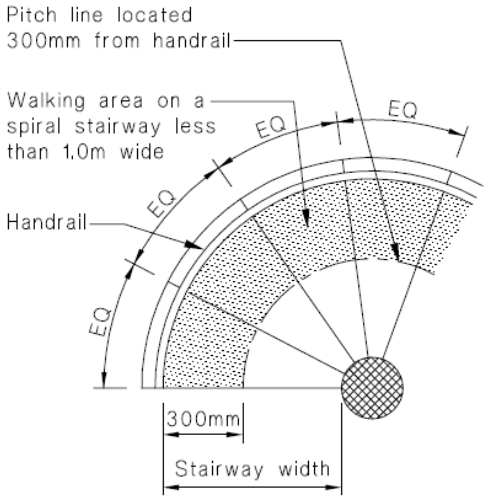
6.0.1 … All other stairways with a width of 2.0m or less and having two or more risers, shall have handrails on at least one side.

6.0.4 Slope of handrails – Handrails shall have the same slope as the pitch line …

Figure 17(a)

Figure 17: Curved Stairway with Tapered Treads
Paragraphs 4.4.1 a) and b) and 4.5.2

Note: Tread depth and riser height measured on the pitch line shall comply with Table 6 and Figure 11.



(a) Spiral stairway width less than 1000mm
(Private and service stairway only)

4.4 Curved and spiral stairways

4.4.1 Curved and spiral stairways with tapered treads shall have their *pitch line* located:

a) For a spiral stairway of width less than 1000 mm – as shown in Figure 17 (a)), and

b) For a curved stairway of width 1000 mm or greater – as shown in Figure 17 (b)).

BS 5395: Part 2 is an acceptable solution for spiral *stairways* having a diameter of no less than 1500 mm.

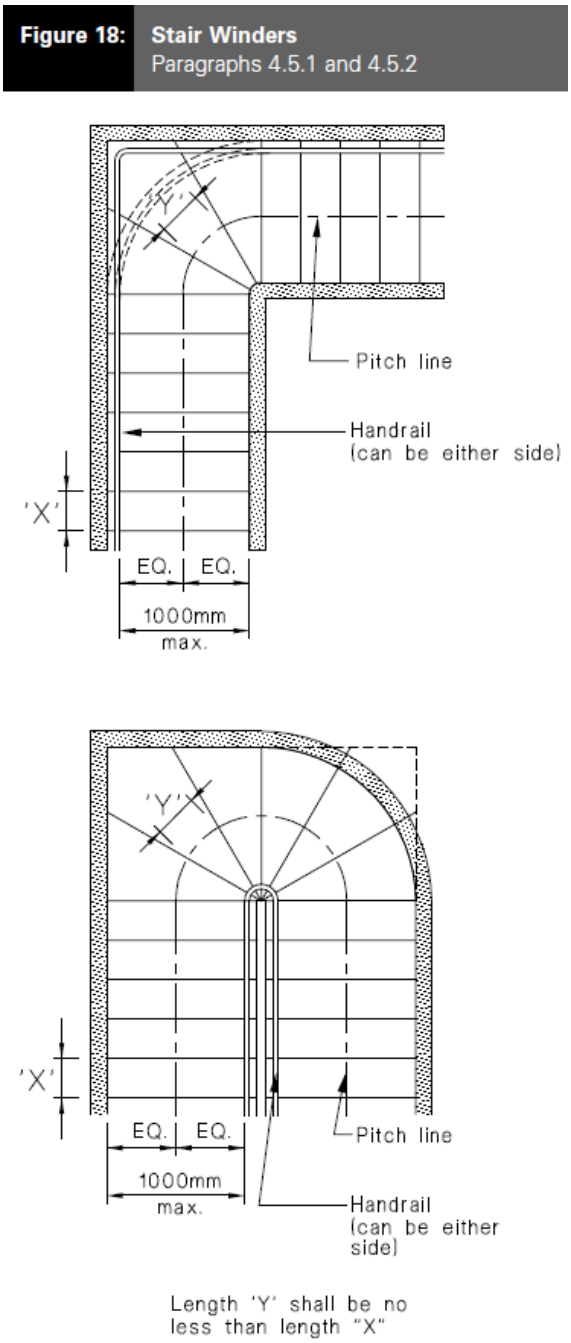
Comment:

1. The dimensions of Figure 17 are based on the assumption that people walk up and down only on the outside of a narrow stairway, but both the inside and outside of wider stairways.

4.4.2 Consecutive tapered treads shall have uniform taper angles. *Pitch line* slope, riser height and tread depth along both *pitch lines* shall comply with Table 6 and Figure 11.

(Table 6 and Figure 11 set out the design limits for maximum pitch, maximum riser height, and minimum tread for service/ minor private, secondary private, common and main private, and accessible stairs)

Figure 18



4.5 Stair winders

4.5.1 Winders are acceptable on private stairways and service stairways provided that all the following conditions are satisfied:

a) Riser heights and tread depths on the pitch line comply with Table 6 and Figure 11.

b) Riser height is uniform and the same as that **on the adjoining straight flights of stairs.** *[my emphasis]*

c) Tread depth on the pitch line is no less than that **on adjoining straight flights of stairs**. *[my emphasis]*

d) Winders have a uniform taper angle.

e) Consecutive winders **do not turn through an angle of more than 180º**. *[my emphasis]*

Appendix B: United Kingdom Regulations, British Standards, and International Code Council Building Code

B.1 United Kingdom Building Regulations 2010 Approved Document K: Protection from falling, collision and impact (2013 edition)

Spiral and helical stairs

1.25 Design stairs in accordance with BS 5395-2

Handrails for stairs

1.33 In situations other than those described in paragraphs 1.31 and 1.32 above [which relate to entrance stairs and buildings other than dwellings]:

a. If the stairs are less than 1m wide: provide a handrail on one or both sides.

…

B.2 British Standard BS 5395: Stairs, ladders and walkways Part 2: Code of practice for the design of helical and spiral stairs (1984).

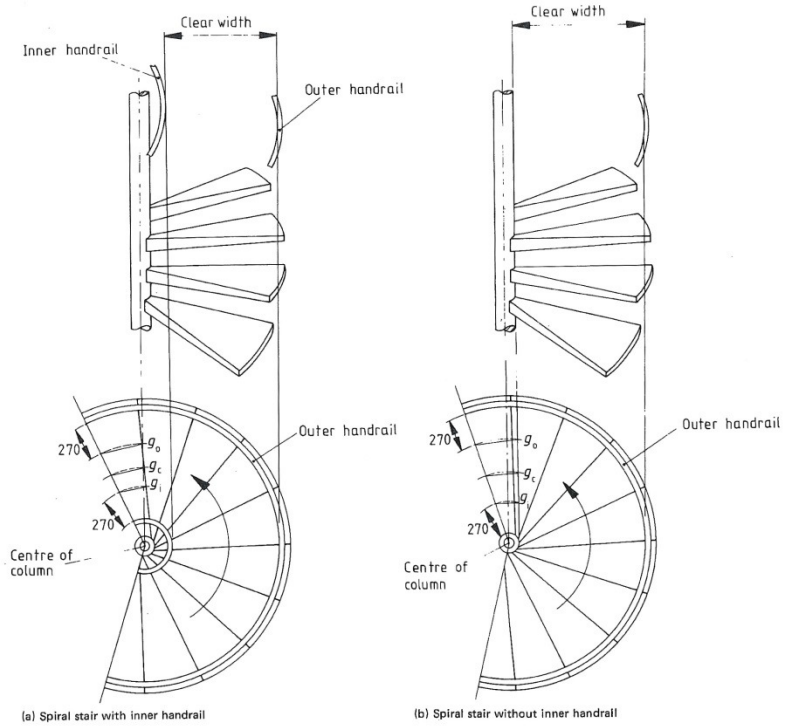
5.8 Guarding of stairs and landings.

…

Balustrades and handrails should follow the recommendations of BS 6180[8] provided that the definition of pitch line given in 2.8 of this standard is used. …

An inner handrail should be provided for semi-public and public stairs (categories C, D and E in table 2).

Figure 3 (see over page)



(a) Spiral stair with inner handrail

(b) Spiral stair without inner handrail

NOTE. Figure 3(a) shows a spiral stair only, but the same method of measurement applies to a helical stair.
All dimensions are in millimetres.

Figure 3. Measurement of clear width and goings

[8] Note: BS 6180:2011 does not address the matter of internal handrails for spiral stairways

B.3 BS 5395-1:2010 Stairs – Part 1: Code of practice for design of stairs with straight flights and winders

4 Safety

4.1 Handrails

Commentary on 4.1

Use of a suitably designed handrail can prevent users from losing their balance when on the stair and can also assist users to ascend by pulling themselves up the stairs. A handrail can also help users to regain balance in the event of a fall, reducing the severity of the injuries that might result.

The need for a handrail on both sides of the stair comes from two sources. Firstly, to allow uses a choice of support when ascending and descending stairs, it is preferable to have a handrail on both sides. … The other reason is that having two handrails reduces the chances of a serious incident happening on a stair.

Every stair should have two continuous handrails, one on each side of the stair, to provide guidance and support to those using the stair. …

Hand rails should: …

c) be fixed parallel to the pitch line over steps, or horizontal over landings;

B.4 International Code Council: International Building Code (2000)

1003.3.3.11 Handrails

Stairways shall have handrails on each side. …

Exceptions …

2. Stairways within dwelling units, spiral stairways and aisle stairs serving seating only on one side are permitted to have a handrail on one side only.