

BSR Compliance Statement

PROJECT X FEATURE STAIRCASE



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1 Introduction

1.1 Scope of Works

Smet staircases has designed, and will produce and instal the feature staircase for the Project X. The staircase is a freestanding, helical staircase with solid plasterboard balustrade and connects the Sixteenth Floor with the Seventeenth Floor. The staircase structure is made of Birch Plywood treads and risers in an L-shape and Beech, underlying stringers. The steps will be stone clad. On the stringers, a hybrid framework and panel balustrade will be installed, consisting of an outside frame to allow for plasterboard, a filling piece in the middle to accommodate for LED lighting, and an inner solid French Oak panel with rounded top edge to allow for a comfortable grip. The supply and installation of the LED lighting and plasterboard is not included in Smet's package.

1.2 Proving Compliance with Building Regulations

This document demonstrates compliance with building regulations as stated in *Approved Document K: Protection from Falling, Collision and Impact* as well as with the *British Standard Stairs, Ladders and Walkways: Part 2. Code of practice for the design of helical and spiral stairs*. BS 5395-2.

This report begins with an extract of the relevant passages of both guides, after which an in-depth analysis of each extract will be applied to the Project X stairs. This document also includes a full engineering report, provided by our engineers at Arqus Engineering.

1.3 In text referencing

In text references to either of these documents is done following the following structure:

(Abbreviation of the document, page number)

For *Approved Document K – Protection from falling, collision and impact*, the abbreviation used is 'Document K'. An in-text reference to this document can look like this: (Document K, 5)

For *British Standard Stairs, Ladders and Walkways: Part 2. Code of practice for the design of helical and spiral stairs*, the abbreviation used is 'British Standard'. An in-text reference to this document can look like this: (British Standard, 5)

2 Extract of Relevant Building Regulations

This is a summary of the relevant approved documents for the demonstrating the compliance with Smet staircases' scope of work. Each section discussed in this document is noted here, with the relevant page numbers.

1. Approved Document K – Protection from falling, collision and impact

Requirement K1: Stairs, ladders, and ramps

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2. British Standard Stairs, Ladders and Walkways: Part 2. Code of practice for the design of helical and spiral stairs. BS 5395-2

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3 Building Regulations applied to Project X staircase

3.1 Approved Document K – Protection from falling, collision and impact

3.1.1 Requirement K1: Stairs, ladders, and ramps

Steepness of stairs – rise and going

Smet staircases measure the rise and going of a stair according to the below diagram.

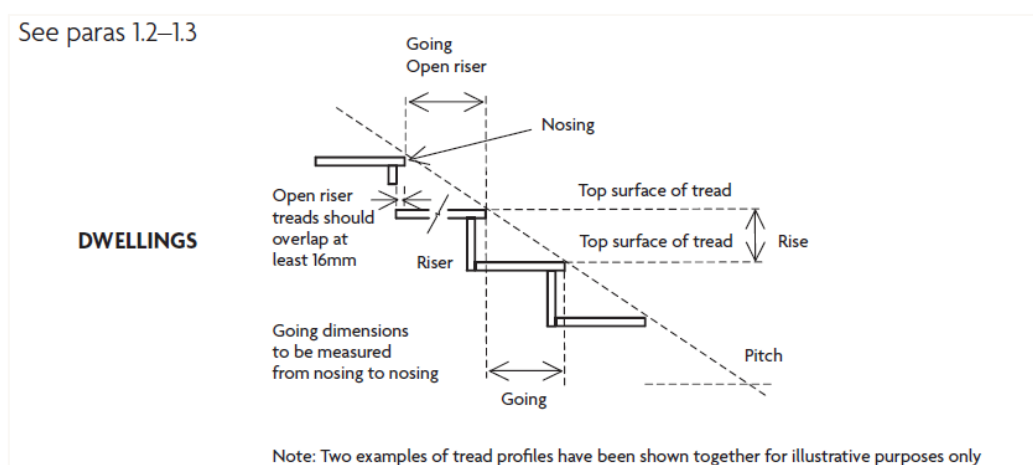


Figure 1: Measuring the rise and going - Document K, 4

This section of document K includes a table with the minimum and maximum requirements for rise and going. However, since the Project X staircase is a helical staircase (as per the definition on page 8), Smet has follow those requirements. (See Table 2. Sizes of Stairs)

Construction of steps

All our treads are calculated to have an equal rise and going throughout a flight of steps (Document K, 6).

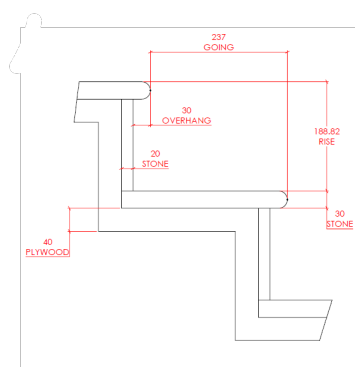


Figure 2: Measurements of the rise and going for the Project X staircase. (SM-0240-X3C-002)

Headroom for stairs

Considering the staircase is placed in a double ceiling height space, Smet's design is automatically compliant with Document K, which requests a minimum head height of 2m (Document K, 7).

Special stairs

For helical stairs, Document K refers to the British standard: BS 5395-2 (Document K, 12). Smet follows the guidelines noted in this document for the Project X stair. Please refer to section 3.2 of this document for any further information on helical stairs.

Guarding of stairs

Smet has confirmed that a sphere of $\varnothing 100\text{mm}$ will not be able to pass through any gaps (Document K, 16). Considering the staircase design has a solid panel balustrade, there are no gaps in the staircase that would need to be checked for this requirement.

Children should not be able to climb the guarding (Document K, 16). Here too, this is not possible considering the solid panel design of the staircase balustrade.

Smet has provided guarding on all sides of the flights and landings where the drop is more than 600mm. (Document K, 17). There is balustrading on both sides of the staircase, as well as on the landing.

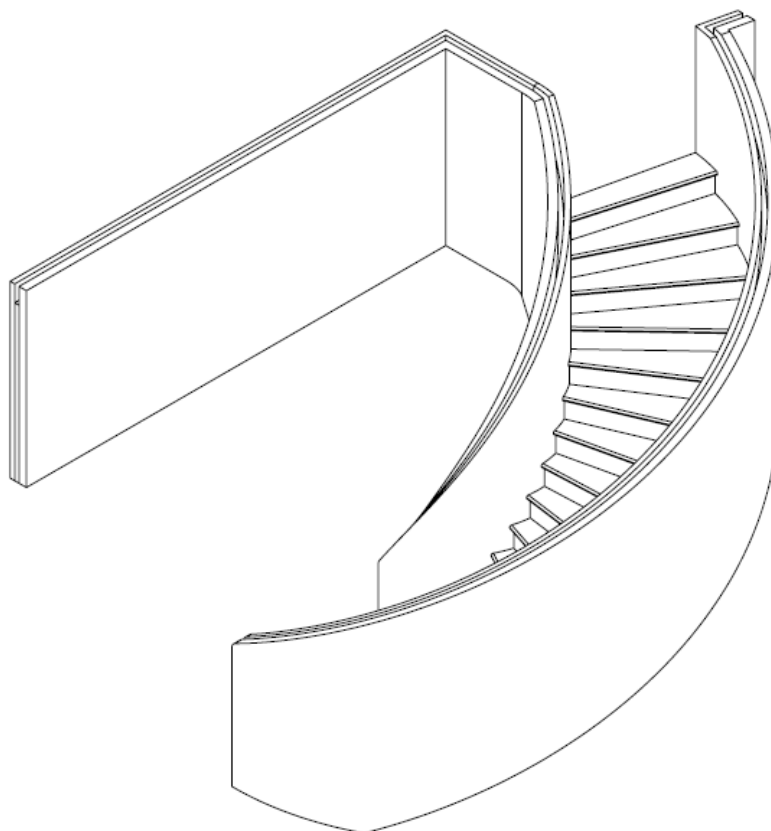


Figure 3: The Project X staircase design has a solid panel balustrade. (SM-0240-X3C-001)

Section 3: Protection from falling

Design of guarding

For Single family dwellings, the minimum height for all guarding elements on stairs and landings should be 900mm.

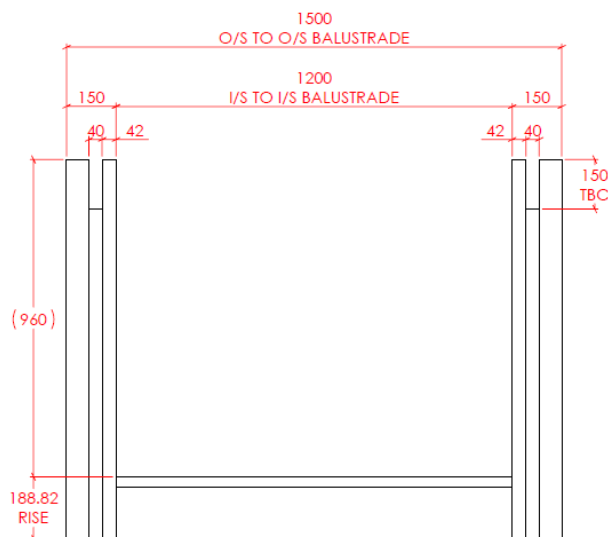


Figure 4: Measurements on a section of the staircase, including the balustrade height, which is 960mm.

Minimum loads are calculated by our engineers and are mentioned in point 4: Engineering report.

3.2 British Standard for Spiral Staircases

Specifically for helical staircases, Smet follows the guidelines as described in BS 5395-2.

Definitions

The Project X stair is a helical staircase, as it is a 'helix around a central void' (British Standard 1).

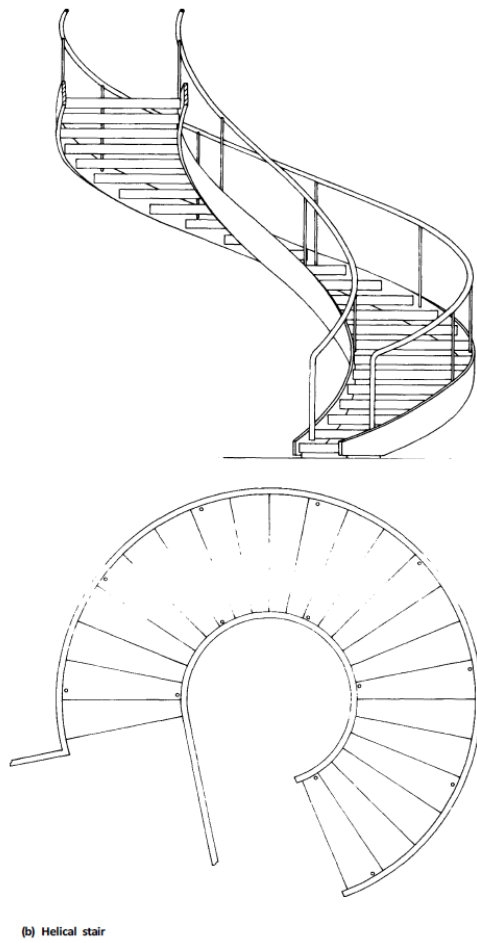


Figure 5: Typical layout of a helical staircase (British Standard, 2).

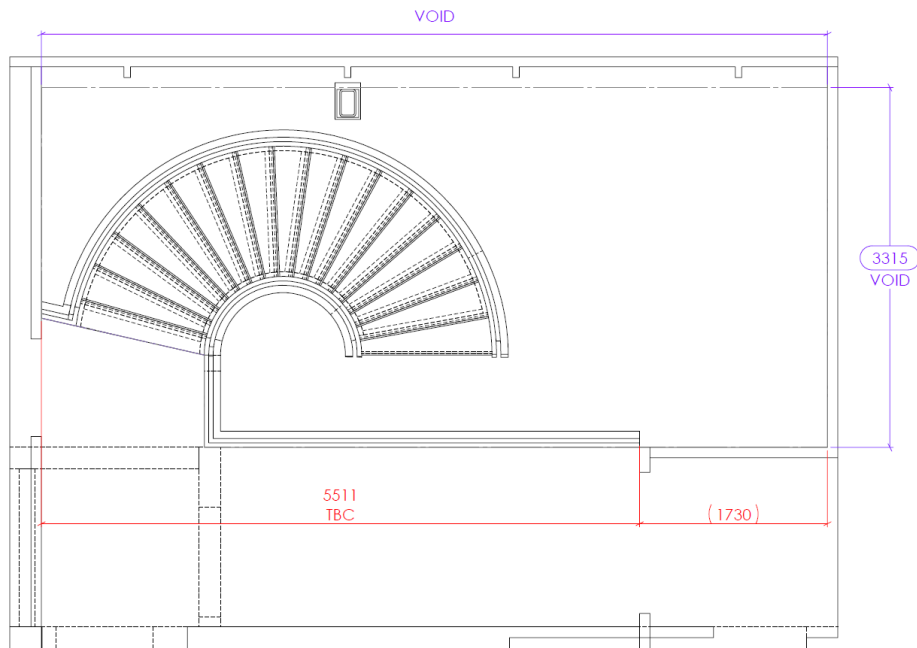


Figure 6: The Project X staircase floorplan indicates a helical staircase. (SM-0240-X3C-003)

Table 2. Sizes of Stairs

Smet designed the staircase according to the minimum and maximum measurements for rise and going of a helical stair, as described below:

1. Stair category	2. Rise, r	3. Going, g			4. 2r + g		5. Clear width*
		Minimum inner going, g _i	Minimum centre going, g _c	Maximum outer going, g _o	Min.	Max.	Min.
B. <i>Private stair*</i> similar to category A but also providing the main access to the upper floor of a private dwelling. Typical outside diameter 1800 mm to 2250 mm	170 to 220	120	190	350	480	800	800

Figure 7: Sizes of stairs for a private, helical staircase (British Standard, 4)

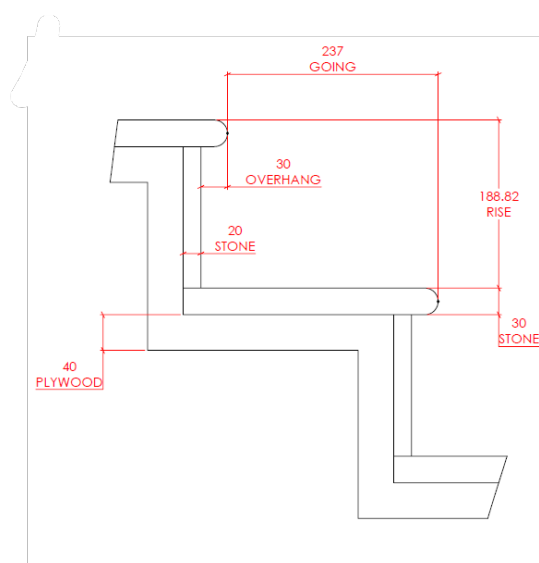


Figure 8: Measurements of the rise and going for the Project X staircase. (SM-0240-X3C-002)

5. Design

Smet has measured the going according to the below:

- The inner going, which is the minimum going, should be measured at a point 270mm horizontally from the inner handrail or from the column face where no inner handrail is fitted.
 - The centre going should be measured at the central point of the clear width.
 - The outer going, which is the maximum going, should be measured at a point 270mm horizontally from the outer handrail or string, whichever is the least radius.
- (British Standard, 6).

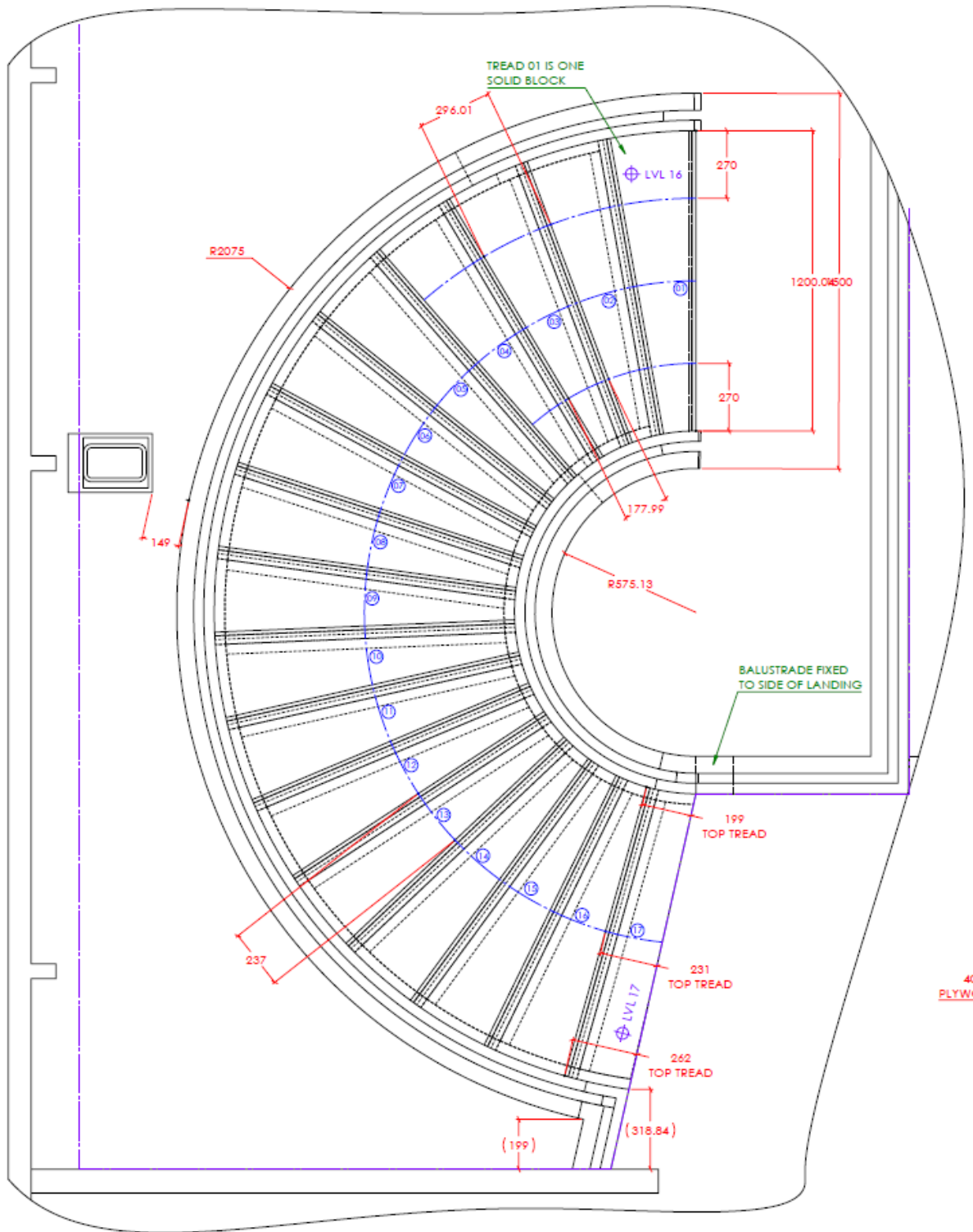


Figure 9: The inner going is 177.99mm, the centre going is 237mm, and the outer going is 296.01mm

4 Engineering Report

Arqus Engineering conducted this engineering study¹.

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1 Versions and Adaptations

Version	Date	Adaptations
00	16/06/2025	First Version
01	26/06/2025	Update length staircase – wood specifications – fixing details
02	17/07/2025	Update UK standards + detailed formulas structural engineering + adjusting live load (150kg/m ²) + structural detailing
03	12/08/2025	Update structural detailing + removing option 6.1 – handrail as a dead load

2 Standard & Technical Documents

The following standards and technical documents were consulted for the drafting of this report.

BS EN 1990: 2002 + NA	Eurocode 0 – Basis of structural and geotechnical design (+A1:2005) + national annex
BS EN 1991-1-1: 2002 + NA	Eurocode 1 Actions on structures – General actions – Densities, self-weight, imposed loads for building + national annex
BS EN 1995-1-1: 2004 + NA	Eurocode 5: Design of timber structures – General. Common rules and rules for buildings (+A2:2014) + national annex

3 Plans and Sections

The following documents were consulted for the design of the structural elements:

- Document Project X_STAIRCASE_I500MM – Design Team Y
- ARQUS report dd. 26-06-2025 - reviewed by A. Antonini_BG&E
- ARQUS report dd. 17-07-2025 - reviewed by A. Antonini_BG&E
- Report of meeting with Smet UK - dd. 04-06-2025
- Plan 3290-BGE-ZZ-ZZ-M3-S-00001 - Section - Section 19
- Following plans from Smet UK:
 - SM-0240-X2-002 rev. P01 dd. 20-06-2025
 - SM-0240-X2A-001 rev. P01 dd. 20-06-2025
 - SM-0240-X2B-001 rev. P01 dd. 20-06-2025

4 Loads and Material Properties

The following loads were taken into account for the calculations.

- Density wood (D50) - t = 13cm 750 kg/m³
- WEDI Board - t = 6mm 20 kg/m²
- Finishing of the stairs(stone) 3,000 kg/m³
 - Front of the stairs = 30mm
 - Top of the stairs = 20mm
- Permanent load finishing bottom side 50 kg/m²
- Permanent load handrail 110 kg/m
 - 42mm wood
 - 22mm multiplex
 - Gyproc
 - Finishing layer
- Live load on the staircase (residential) 150 kg/m²
- Live load handrail 36 kg/m

The following material characteristics were taken into account for the calculations:

- Stair beams: beech - quality D50
- Stairs MPX panels in birch
- Solid panels: French oak - quality C24



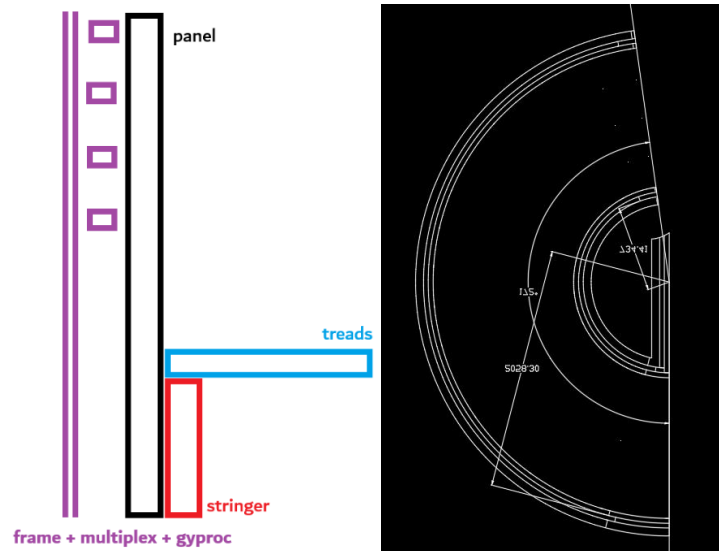
5 Structural Principle and Geometry

Different options for the staircase were considered, the option with a width of 150cm was withheld for these calculations.

For the structural principle, two cases were considered.

- Option 1 where the wooden panel that is used as handrail is considered as a dead load and does not work as a structural element - **not withheld**.
- Option 2 where the wooden panel that is used as handrail is considered as a structural element= beam that supports the staircase - **withheld**

The principle is sketched in the section below, in black is the wooden panel, in red is the beam that was not considered as being structural but as a dead load for the wooden panel.



The two beams have different lengths:

- Inner beam has a total horizontally projected length of 2.25m
- Outer beam has a total horizontally projected length of 6.20m

6 Results and Structural Detailing

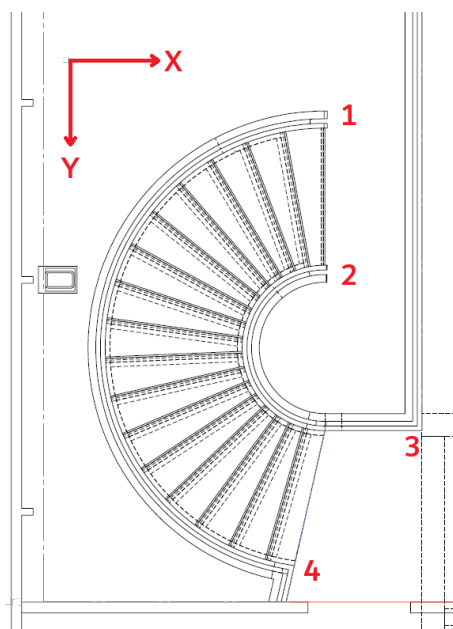
6.1 Reaction forces

The handrail was considered as a structural element with dimensions of 42x1200mm² - quality of the wood C24. The beams in solid wood – drawn in red on the picture in part 5 – were not considered as structural elements, they were however considered as dead load, for the installation of the stairs.

With the use the loads as described under paragraph 4, the maximum allowable stress is not exceeded, and the structure can be viewed as safe from a structural engineering standpoint. Detailed calculations are mentioned in part 8

The reaction forces are mentioned in the following table - Ultimate limit state: safety of 1.35 for permanent loads and 1.50 for live loads - and the points are shown in the ground floor plan. The Y-direction is the vertical reaction.

POINT	X	Y (vertical)	Z
1	-7.0 kN	-2.1 kN	-4.0 kN
2	23.9 kN	29.9 kN	7.0 kN
3	-24.9 kN	29.9 kN	-1.6 kN
4	7.9 kN	-2.1 kN	-1.4 kN



The vertical deflection - creep was considered for the wooden structural elements - for this solution are:

- 9.8mm in the frequent combination
- 9.0mm in the quasi-permanent combination

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6.2 Vibration

For the checking of the vibration, the value of the fundamental frequency was calculated following equation 7.5 in Eurocode 5. Where the length was considered as the average of both beam lengths since they are well connected with each other.

$$f_1 = \frac{\pi}{2\ell^2} \sqrt{\frac{(EI)_\ell}{m}}$$

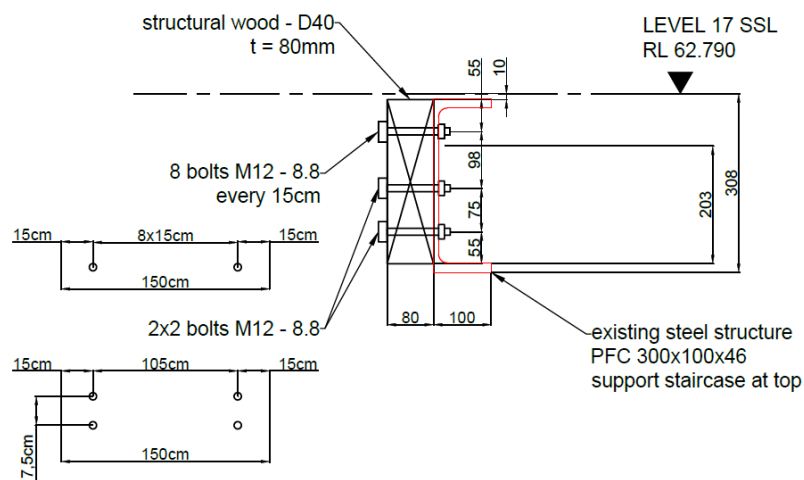
The fundamental frequency remains well above 8Hz and thus the staircase can be considered as 'safe' for the residential application.

7 Structural Detailing

7.1 Top of the Staircase

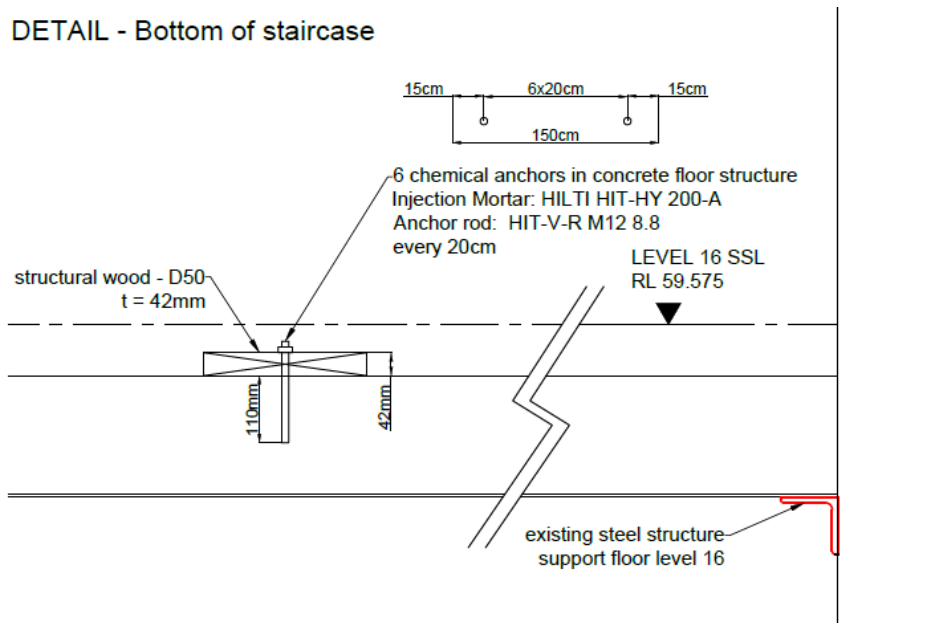
At the top of the staircase the structure will be connected to an existing steel structure as shown in the detail below.

DETAIL - Top of staircase



7.2 Bottom of the Staircase

At the bottom of the staircase the structure will be connected to the concrete floor by using a wooden structural beam with a thickness of 42mm as shown in the detail below



8 Detailed Calculations – ULS

8.1 Tension

Axial tension was checked with the following formula from Eurocode 5

$$N_{t,Rd} = \frac{A \cdot f_{t,0,k} \cdot k_{mod}}{\gamma_M} \leq N_{t,Ed} \quad \text{or} \quad \sigma_{t,Rd} = \frac{N_{t,Rd}}{A} = \frac{f_{t,0,k} \cdot k_{mod}}{\gamma_M} \leq \sigma_{t,Ed}$$

Using the following values, the maximum allowable stress equals 8.6N/mm².

- $A = 42 \times 1,200 \text{ mm}^2 = 50,400 \text{ mm}^2$
- $f_{t,0,k} = 14.0 \text{ N/mm}^2$
- $k_{mod} = 0.8$ –
- $\gamma_m = 1.30$ –

The maximum tension stress in the structural beams is less than 10% of the maximum allowable stress.

$f_{t,0,k}$	=	14.0	N/mm ²
γ_m	=	1.3	-
k_{mod}	=	0.8	-
A	=	504	cm ²
$\sigma_{t,Rd}$	=	8.6	N/mm ²
$N_{t,Rd}$	=	434.2	kN
$N_{t,Ed}$	=	38.0	kN
U.C.	=	9%	OK

8.2 Compression

Axial compression was checked with the following formula from Eurocode 5

$$N_{c,Rd} = \frac{A \cdot f_{c,0,k} \cdot k_{mod}}{\gamma_M} \leq N_{c,Ed} \quad \text{or} \quad \sigma_{c,Rd} = \frac{N_{c,Rd}}{A} = \frac{f_{c,0,k} \cdot k_{mod}}{\gamma_M} \leq \sigma_{c,Ed}$$

Using the following values the maximum allowable stress equals 8.6N/mm²

- $A = 42 \times 1,200 \text{ mm}^2 = 50,400 \text{ mm}^2$
- $f_{c,0,k} = 21.0 \text{ N/mm}^2$
- $k_{mod} = 0.8$ –
- $\gamma_m = 1.30$ –

The maximum compression stress in the structural beams is equal to 6% of the maximum allowable stress.

$F_{c,0,k}$	=	21	N/mm ²
γ_m	=	1.3	-
k_{mod}	=	0.8	-
A	=	504	cm ²
$\sigma_{c,Rd}$	=	12.9	N/mm ²
$N_{c,Rd}$	=	651.3	kN
$N_{c,Ed}$	=	38.0	kN
U.C.	=	6%	OK

8.3 Shear – Strong Axis

Shear over the strong axis was checked with the following formula from Eurocode 5

$$V_{y,Rd} = \frac{A_{el,y} * f_{v,k} * k_{mod}}{\gamma_M} \leq V_{y,Ed} \quad \text{OR} \quad \tau_{y,Rd} = \frac{V_{y,Rd}}{A_{el,y}} = \frac{f_{v,k} * k_{mod}}{\gamma_M} \leq \tau_{y,Ed}$$

Using the following values, the maximum allowable shear stress equals 2.5N/mm².

- $A_{el,z} = (1/1.5) \times 42 \times 1,200 \text{ mm}^2 = 33,600 \text{ mm}^2$
- $f_{v,k} = 4.0 \text{ N/mm}^2$
- $k_{mod} = 0.8$ –
- $k_{cr} = 0.67$ –
- $\gamma_m = 1.30$ –

The maximum shear stress in the structural beams is equal to 23% of the maximum allowable stress.

$f_{v,k}$	=	4	N/mm ²
γ_m	=	1.3	-
k_{mod}	=	0.8	-
k_{cr}	=	0.67	
$A_{el,y}$	=	336	cm ²
$f_{v,Rd}$	=	2.5	N/mm ²
$V_{y,Rd}$	=	55.4	kN
$V_{y,Ed}$	=	12.9	kN
U.C.	=	23%	OK

8.4 Shear – Weak Axis

Shear over the weak axis was checked with the following formula from Eurocode 5

$$V_{z,Rd} = \frac{A_{el,z} \cdot f_{v,k} \cdot k_{mod}}{\gamma_M} \leq V_{z,Ed} \quad \text{or} \quad \tau_{z,Rd} = \frac{V_{z,Rd}}{A_{el,z}} = \frac{f_{v,k} \cdot k_{mod}}{\gamma_M} \leq \tau_{z,Ed}$$

Using the following values the maximum allowable shear stress equals 2.5N/mm².

- $A_{el,z} = (1/1.5) \times 42 \times 1,200 \text{mm}^2 = 33,600 \text{mm}^2$
- $f_{v,k} = 4.0 \text{ N/mm}^2$
- $k_{mod} = 0.8$ -
- $k_{cr} = 0.67$ -
- $\gamma_m = 1.30$ -

The maximum shear stress in the structural beams is equal to 10% of the maximum allowable stress.

$f_{v,k}$	=	4	N/mm ²
γ_m	=	1.3	-
k_{mod}	=	0.8	-
k_{cr}	=	0.67	
$A_{el,z}$	=	336	cm ²
$f_{v,Rd}$	=	2.5	N/mm ²
$V_{z,Rd}$	=	55.4	kN
$V_{z,Ed}$	=	5.7	kN
U.C.	=	23%	OK

8.5 Torsion

Torsion was checked with the following formula from Eurocode 5

$$\tau_{tor,Rd} = k_{shape} * f_{v,Rd} \leq \tau_{tor,Ed}$$

Using the following values the maximum allowable stress equals 3,5N/mm².

- $f_{v,Rd} = 2.5 \text{ N/mm}^2$
- $k_{shape} = 1.43 -$

The maximum stress in the structural beams is equal to 12% of the maximum allowable stress.

$f_{v,k}$	=	4	N/mm ²
γ_m	=	1.3	-
k_{mod}	=	0.8	-
k_{shape}	=	1.43	-
$\tau_{tor,Rd}$	=	3.5	N/mm ²
$V_{tor,Rd}$	=	1.7	kNm
$V_{tor,Ed}$	=	0.2	kNm
U.C.	=	12%	OK

8.6 Double Bending

(Double) bending stress was checked with the following formula from Eurocode 5

$$\frac{\sigma_{m,y,d}}{f_{m,y,d}} + k_m * \frac{\sigma_{m,z,d}}{f_{m,z,d}} \leq 1,0 \quad \text{and} \quad k_m * \frac{\sigma_{m,y,d}}{f_{m,y,d}} + \frac{\sigma_{m,z,d}}{f_{m,z,d}} \leq 1,0$$

$$f_{m,\frac{y}{z},d} = \frac{k_{mod} * k_h * f_{m,k} * k_{mod}}{\gamma_M}$$

Using the following values the maximum allowable shear stress equals 2.5N/mm².

- $K_h = 0.7$ -
- $f_{m,k} = 24.0$ N/mm²
- $k_{mod} = 0.8$ -
- $k_m = 0.70$ -
- $\gamma_m = 1.30$ -

The maximum (double) bending stress in the structural beams is equal to 40% of the maximum allowable stress, thus the structure is safe.

$f_{m,k}$	=	24.0	N/mm ²
γ_m	=	1.3	-
k_{mod}	=	0.8	-
k_h	=	0.7	-
$f_{m,d}$	=	10.3	N/mm ²
$\sigma_{m,y,d}$	=	0.6	N/mm ²
$\sigma_{m,z,d}$	=	3.7	N/mm ²
k_m	=	0.7	-
DB	=	0.4	-
U.C.	=	40%	OK

8.7 Double Bending + Tension

The combination of double bending + tension was checked with the following formula from Eurocode 5.

$$\frac{\sigma_{t,0,d}}{f_{t,0,d}} + \frac{\sigma_{m,y,d}}{f_{m,y,d}} + k_m * \frac{\sigma_{m,z,d}}{f_{m,z,d}} \leq 1,0$$

$$\frac{\sigma_{t,0,d}}{f_{t,0,d}} + k_m * \frac{\sigma_{m,y,d}}{f_{m,y,d}} + \frac{\sigma_{m,z,d}}{f_{m,z,d}} \leq 1,0$$

The maximum stress in the structural beams is equal to 48% of the maximum allowable stress, thus the structure is safe.

$\sigma_{t,0,d}$	=	0.8	N/mm ²
$f_{t,0,d}$	=	8.6	N/mm ²
$\sigma_{m,y,d}$	=	0.6	N/mm ²
$f_{m,y,d}$	=	10.3	N/mm ²
$\sigma_{m,z,d}$	=	3.7	N/mm ²
$f_{m,z,d}$	=	10.3	N/mm ²
DBT	=	0.5	-
U.C.	=	48%	OK

8.8 Double Bending + Compression

The Combination of double bending + compression was checked with the following formula from Eurocode 5.

$$\left(\frac{\sigma_{c,0,d}}{f_{c,0,d}}\right)^2 + \frac{\sigma_{m,y,d}}{f_{m,y,d}} + k_m * \frac{\sigma_{m,z,d}}{f_{m,z,d}} \leq 1,0$$

$$\left(\frac{\sigma_{c,0,d}}{f_{c,0,d}}\right)^2 + k_m * \frac{\sigma_{m,y,d}}{f_{m,y,d}} + \frac{\sigma_{m,z,d}}{f_{m,z,d}} \leq 1,0$$

The maximum stress in the structural beams is equal to 40% of the maximum allowable stress, thus the structure is safe.

$\sigma_{c,0,d}$	=	0.8	N/mm ²
$f_{c,0,d}$	=	12.9	N/mm ²
$\sigma_{m,y,d}$	=	0.6	N/mm ²
$f_{m,y,d}$	=	10.3	N/mm ²
$\sigma_{m,z,d}$	=	3.7	N/mm ²
$f_{m,z,d}$	=	10.3	kN
DBT	=	0.4	-
U.C.	=	40%	OK

Annex – Document Schedule

DRAWING	DESCRIPTION / TITLE	STATUS
SM-0240-X3C-001	Option C – Isometric Drawing	Coordinated Design
SM-0240-X3C-002	Option C – Plan Drawing	Coordinated Design
SM-0240-X3C-003	Option C – Plan Drawing	Coordinated Design
VERSION	DESCRIPTION/TITLE	
Version 03	Engineering Report: Smet – Staircases of Distinction Project X	