
Guidelines for SINTEF Technical Approval

Glass railing

Railing with glass as complementary or load carrying element

1. General information about SINTEF Technical Approval

A general orientation concerning SINTEF Technical Approval may be found here;
<https://www.sintefcertification.no/file/index/2956>

2. Properties to be included in the approval and how the properties are determined

In cases where the product has already been thoroughly documented according to recognized methods, and a report exists in either English or a Scandinavian language, then this should be enclosed with the application. If such documentation does not exist, then type testing will be conducted at SINTEF Building and Infrastructure according to the methods and requirements presented in this document.

A SINTEF Technical Approval for glass railing shall usually declare the following product properties:

Requirements for glass railings according to the Norwegian civil regulations (TEK10) § 12-16 and § 12-17 and it's guide

- The railing shall have a height and design that prevents people from falling through it. The railing shall have a design that prevents it from being climbed upon, thus possible balusters shall be vertically aligned.
- Railing height in stairs and ramps shall be a *minimum* of 0.9 m. The railing height at balconies, grandstands, passages and such, shall be a *minimum* of 1.0 m. Where the level difference is more than 10.0 m, the railing height shall be a minimum of 1.2 m.
- The openings in railings shall in a vertical distance up until 0.75 m from the floor/deck be less than 0.10 m vertically and 0.02 m horizontally.* The horizontal distance between building component and surface mounted railing shall be less than 0.05 m. (Correspondingly, the opening between the railing's lower edge and the floor/step shall be less than 0.05 m.)**
- The handrails on railings attached to stairs and ramps shall be at a height of 0.9 m above the floor/step. The height is measured from the front edge of the step. The handrail shall have an approximately circular cross section.
- Stairs and ramps shall have handrails on both sides. In buildings with requirements concerning accessible dwelling units or universal design, the handrail shall be designed such that it provides a good grip and have an approximately circular cross section. In such buildings handrails shall be installed at two levels on both sides, where the top edge of the upper and lower handrail shall be 0.9 m and 0.7 m, respectively above the front edge of the step. The handrail shall pass beyond the stair's upper and lower step with rounded ends. The handrails shall follow the stairway, also at repos.
- The handrails on railings shall be designed such that it does not invite to placing objects upon it.
- Handrail Design: must have an inclination of minimum 1:10 when curved design with a maximum radius of 250 mm. At horizontal profile the maximum horizontal width is 45 mm.

* In the proposal to the new Norwegian civil regulations (TEK17) it is proposed that the maximum opening between the handrail and the underlying rail shall be 0.25 m.

** According to the guidelines for TEK10.

There shall be a luminance contrast between the handrail and the background of at least 0.8* according to § 12-17 (5) in TEK10, for buildings with requirements concerning accessible dwelling units or universal design. The producer is responsible to verify the compliance for this requirement for each railing when the background colour is decided.

Categories of use

Depending on which usage is expected of the glass railing, it shall be tested for the requirements applicable for the relevant category of usage according to Table NA 6.1 in NS-EN 1991-1-1:2002+NA:2008, rendered in Table 1 below.

Table 1 Categories of use with examples of usage according to NS-EN 1991-1-1:2002+NA:2008

Category	Specific use	Example
A	Areas for domestic and residential activities	Rooms in residential buildings and houses; bedrooms and wards in hospitals; bedrooms in hotels and hostels kotchens and toilets
B	Office areas	
C	Areas where people may congregate (With the exception of areas defined under category A, B and D)	<p>C1: Areas with tables, etc. E.g. areas in schools, cafés, restaurants, dining halls, reading rooms, receptions.</p> <p>C2: Areas with fixed seats, e.g. areas in churches, theatres or cinemas, conference rooms, lecture halls, assembly halls, waiting rooms, railway waiting rooms.</p> <p>C3: Areas without obstacles for moving people, e.g. areas in museums, exhibition rooms, etc. and access areas in public and administration buildings, hotels, hospitals, railway station forecourts.</p> <p>C4: Areas with possible physical activities, e.g. dance halls, gymnastic rooms, stages.</p> <p>C5: Areas susceptible to large crowds, e.g. in buildings for public events like concert halls, sport halls including stands, terraces and access areas in railway platforms.</p>
D	Shopping areas	<p>D1: Areas in general retail shops</p> <p>D2: Areas in department stores</p>

Reaction to fire

Generally not relevant for glass railings. The separation screens at glassed in balconies for different residential units shall be assessed.

Material properties

Freely exposed edges of the glass shall be polished, or as a very least be brushed.

The applied safety glass shall be certified by a designated technical organization, or CE-marked.

Steel, aluminium and welded products shall be produced according to NS-EN 1090-1

* In the proposal to the new Norwegian civil regulations (TEK17) a value of 0.4 is suggested.

Durability

Depending on the which usage is intended of the glass railing, a durability assessment shall be performed for;

- Timber is assessed by type of timber, properties and treatment
- Metal components are assessed by it's corrosion treatment
- Rubber strips and sealings shall have sufficient hardness and elasticity. For outdoor usage they shall be resistant to moisture, cold and warm temperatures, and UV radiation. Rubber sealings exposed to sunlight should for instance be age tested for two weeks exposed to UV radiation and 12 weeks for heating, according to EN 1296 and EN 1297.

If laminated glass with freely exposed edges is used in the railing, airing of the glass must be facilitated. Correspondingly, if the glass is installed in grooves airing and drainage must be facilitated.

Environmental documentation

Environmental properties shall be documented for all products (simple and complex) that are to be given a SINTEF Technical Approval. Requirements for material and product descriptions concerning environmental product properties may be found here;

For glass railings the following properties shall be documented:

- Prioritized hazardous substances
- Emissions to the indoor air (indoor use)
- Leaching to the ground or soil (outdoor use)
- Waste treatment at end of service life

Products that contain prioritized hazardous substances shall in principle not be given a SINTEF Technical Approval (zero tolerance). The rejection may be given if hazardous substances, that are prohibited or should be phased out, are added to the product during production. The Norwegian Priority List can be found here:

<http://www.environment.no/topics/hazardous-chemicals/lists-of-hazardous-substances/list-of-priority-substances/>

For products that are intended for indoor use there may be required to perform emission testing for some components. Glass and pure metals are considered as low-emitting materials with no testing requirements. Emission testing may be required for metals coated with plastic, sealing details, e.g. rubber. The emissions tests shall be performed according to the ISO 1600 series. The products shall be documented as low-emitting (EN 15251 Annex C).

For products that are intended for outdoor usage leaching to the soil and ground water will be assessed. Leaching documentation may be required. This is relevant for metals covered with plastic, sealing details, e.g. rubber.

If an environmental declaration (EPD) has been worked out for the product or one of its components parts of it may be incorporated into the approval document.

Type testing

Table 2 displays relevant properties that shall be assessed for the type testing.

Table 2

Properties, methods and requirements for glass railing depending on usage category and level difference from floor to railing

Property	Method/reference	Level difference	Unit	Usage category (According to NS-EN 1991-1-1 Table 6.1)			
				A	B & C1	C2 - C4 & D	C5
Impact resistance ¹⁾	NS-EN 12600 and NS 3510	$h_n \leq 0,5 \text{ m}$	-	3(B)3 or 1(C)3	2(B)2 or 1(C)2	2(B)2 or 1(C)2	1(B)1 or. 1(C)1
		$h_n > 0,5 \text{ m}$	-	3(B)3	2(B)2	2(B)2	1(B)1
Horizontal line load on handrail (Imposed load) ²⁾	NS 3510 Table B.1	-	kN/m	1,0	1,0	1,5	3,0
Uniform horizontal load on glass ³⁾	NS-EN 3510 Table B.1	-	kN/m ²	1,0	1,0	1,5	3,0
Point load on glass ⁴⁾	NS-EN 3510 Table B.1	-	kN	0,25	0,25	0,25	0,5
Rail fixing	Calculations according to relevant NS-EN	-	kN/m	1,0	1,0	1,5	3,0

1) Drop height class 3, 2 and 1 corresponds to drop heights 190, 450 and 1200 mm, respectively.

2) The load acts at the railing's top edge or at a maximum distance of 1.2 m from the floor level.

3) The uniform load acts from the floor to a maximum height of 1200 mm above the floor.

4) The point load acts at the centre of the glass at a maximum height of 1000 mm from the floor surface distributed over an area of 100 x 100 mm.

Type testing will generally be performed at SINTEF Building and Infrastructure's premises in Forskningsveien 3B, Oslo. The applicant is required to present the necessary number of glass, posts, fasteners, handrails etc. for testing. The applicant is also required to present the required personnel for mounting the railing and accompanying glass.

The testing will generally be performed on sections of the railing with widths of 1 m, or according to the clients requirements. The rail will be tested until fracture. The applicant must provide technical drawings of the glass railing in advance of the testing in order to secure that the drawings are in compliance with the test specimen. Tests will be performed based on the design of the glass and railing in addition to it's size. Screws and fasteners shall be defined in advance.

Table 3
Relevant tests and number of specimens for each test

Property	Number of specimens	Requirement
Pendulum test, equivalent to NS-EN 12600 but glass mounted on railing	4 specimens for each drop height, a maximum of two drop heights	See requirements in Table 2, but shall at least for fill requirements for drop height class 2 at the centre of the glass
Line-load on handrail (as a primary horizontal load)	4 specimens are loaded until fracture. Stiffness is recorded during testing* Load duration shall be less than or equal to 30 seconds at designated imposed load. For imposed loads in usage category C5 the load duration will be assessed for each case	<i>Deflection</i> ≤ 50 mm or $l/20$, where l is the shortest span, for loading equal to 1.0 x imposed load. <i>Fracture load.</i> For metal railings the requirements is > 1.5 x imposed load.** For glass railing the requirement is defined in tables for each product in NS 3510.***
Uniform load on glass*	4 specimens are loaded till required load, equal to 1.0 x imposed load. Optionally further loaded until 1.35 x and 1.50 x imposed load. Load duration shall be less than or equal to 30 seconds at designated imposed load. For imposed loads in usage category C5 the load duration will be assessed for each case	<i>Deflection</i> ≤ 50 mm or $l/20$, where l is the shortest span, for loading equal to 1.0 x imposed load. <i>Fracture load.</i> For metal railings the requirements is > 1.5 x imposed load.** For glass railing the requirement is defined in tables for each product in NS 3510.***
Point load on glass	4 specimens are loaded till required load, equal to 1.0 x imposed load. Optionally further loaded until 1.35 x and 1.50 x imposed load. Load duration shall be less than or equal to 30 seconds at designated imposed load. For imposed loads in usage category C5 the load duration will be assessed for each case	<i>Deflection</i> ≤ 50 mm or $l/20$, where l is the shortest span, for loading equal to 1.0 x imposed load. <i>Fracture load.</i> For metal railings the requirements is > 1.5 x imposed load.** For glass railing the requirement is defined in tables for each product in NS 3510.***
Rail fixing to underlying structure	Calculations according to relevant NS-EN (required design resistance load on fasteners) from applicant.	Calculations shall satisfy current relevant standards.

* For railings with glass as a complementary element the posts and handrails connected together will be tested separately. Glass railing, as shown in NS 3510 Table A.1 to Table A.6 will generally not be tested for uniform and point loads.

** When testing metal railings, deflections greater than 200 mm are considered fracture.

*** Unless documentation is provided that shows the glass is of a higher quality.

Wind loads shall be considered for each case. If the wind load is lower than the uniform load, railing that is lower than 1.2 m may be considered designed also for wind loads.

In general the requirements in NS 3510 shall be met, unless it can be documented that the quality is better than what is required in NS 3510.

3. Description of the manufacturer's factory production control

As a basis for the approval SINTEF must receive a copy of the description of the manufacturer's control plan for the product. This may be the relevant part of the manufacturer's quality control system for the product, or other documentation describing the manufacturer's factory production control. The person responsible for the factory production control shall be identified.

The control plan shall as a minimum describe the controls performed for:

- Incoming materials
- The production process
- Finished product
- Marking and storage

Including the control frequency, how the controls are performed and by whom.

The factory production control description shall also include what measures are taken when faults are observed in the production or in the product.

4. Supervisory production control

The production shall be subject to a supervisory product and production control performed by an independent body. General description of how the supervisory product and production control are performed is available at;

<http://www.sintefcertification.no/en-us/PortalPage.aspx?pageid=180>

Three inspections shall be performed during the approval's period of validity of five years. The inspections shall be performed as factory visits at the supplier/manufacturer. Additional inspections of the installation at the construction site may be included in the control description, thus as an audit testing according to section 3.3 in the standard factory production control description.

The supervisory production control by SINTEF Building and Infrastructure will primarily control the following:

- That the manufacturer utilizes the materials and components as specified in the Technical Approval of the specific product.
- That the manufacturer at each project/delivery utilizes the structural details as specified in the Technical Approval.

The performance control is done through visual inspection and by gathering information from users who utilize the product. The control shall assess if the glass railing is installed and works as intended, and if corrections in the approval document is necessary.

5. Application for SINTEF Technical Approval and project management

Information regarding application and project management for SINTEF Technical Approval is available at;

<http://www.sintefcertification.no/en-us/PortalPage.aspx?pageid=180>

6. More information

Further information about SINTEF Technical Approval can be found on www.sintefcertification.no.