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Permanent counterweighted guardrail systems — Specification



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Foreword

Publishing information

This British Standard is published by BSI Standards Limited, under licence from The British Standards Institution, and came into effect on 30 June 2021. It was prepared by Technical Committee B/514, *Access and support equipment*. A list of organizations represented on this committee can be obtained on request to its committee manager.

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The provisions of this standard are presented in roman (i.e. upright) type. Its requirements are expressed in sentences in which the principal auxiliary verb is “shall”.

Commentary, explanation and general informative material is presented in smaller italic type, and does not constitute a normative element.

Where words have alternative spellings, the preferred spelling of the Shorter Oxford English Dictionary is used (e.g. “organization” rather than “organisation”).

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1 Scope

This British Standard specifies requirements for the design, performance, testing, inspection, marking and instructions for use of manufactured free-standing permanent guardrails that rely on mass and friction and are intended to protect workers from a fall hazard. These guardrails are not fixed to a structure.

This British Standard does not apply to:

- a) temporary counterweighted guardrails (see BS EN 13374);
- b) warning chains/posts used for demarcation;
- c) netting or infill panels used as barriers;
- d) guardrails that penetrate the structure and secure to the substrate;
- e) guardrails designed to support material-handling equipment; and
- f) guardrails intended for use on surfaces with a slope of more than 5°.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application¹⁾. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

[BS 1139-1.2](#), *Metal scaffolding — Part 1: Tubes — Section 1.2: Specification for aluminium tube*

BS EN 74 (all parts), *Couplers, spigot pins and baseplates for use in falsework and scaffolds*

BS EN 39, *Loose steel tubes for tube and coupler scaffolds — Technical delivery conditions*

BS EN 338, *Structural timber — Strength classes*¹⁾

BS EN 1990, *Eurocode — Basis of structural design*

NA+A1:2014 to BS EN 1993-1-1:2005+A1: 2014, *UK National Annex to Eurocode 3: Design of steel structures — Part 1-1: General rules and rules for buildings*

NA to BS EN 1993-1-2, *Eurocode 3: Design of steel structures — Part 1-2: General rules — Structural fire design*

NA to BS EN 1993-1-3, *Eurocode 3: Design of steel structures — Part 1-3: General rules — Supplementary rules for cold-formed members and sheeting*

NA+A1:2015 to BS EN 1993-1-4:2006+A1: 2015, *Eurocode 3: Design of steel structures — Part 1-4: General rules — Supplementary rules for stainless steels*

NA+A1:2016 to BS EN 1993-1-5: 2006 *Eurocode 3: Design of steel structures — Part 1-5: Plated structural elements*

BS EN 1993-1-6, *Eurocode 3: Design of steel structures — Part 1-6: Strength and stability of shell structures*

NA to BS EN 1995-1-1, *Eurocode 5: Design of timber structures — Part 1-1: General — Common rules and rules for buildings*

NA to BS EN 1995-1-2, *Eurocode 5: Design of timber structures — Part 1-2: General — Structural fire design*

NA to BS EN 1999-1-1, *Eurocode 9: Design of aluminium structures — Part 1-1: General structural rules*

¹⁾ Documents that are referred to solely in an informative manner are listed in the Bibliography.

NA to BS EN 1999-1-2, *Eurocode 9: Design of aluminium structures — Part 1-2: Structural fire design*

NA to BS EN 1999-1-3, *Eurocode 9: Design of aluminium structures — Part 1-3: Structures susceptible to fatigue*

NA to BS EN 1999-1-4, *Eurocode 9: Design of aluminium structures — Part 1-4: Cold-formed structural sheeting*

NA to BS EN 1999-1-5, *Eurocode 9: Design of aluminium structures — Part 1-5: Shell structures*

BS EN 13411 (all parts), *Terminations for steel wire ropes*

BS EN ISO 3834-1, *Quality requirements for fusion welding of metallic materials — Part 1: Criteria for the selection of the appropriate level of quality requirements*

3 Terms and definitions

For the purposes of this British Standard, the following terms and definitions apply.

3.1 competent person

designated person suitably trained or qualified by knowledge and practical experience to enable the required task or tasks to be carried out correctly

[SOURCE: BS 8437:2005+A1:2012, 3.10]

3.2 continuous return

return section of permanent counterweighted guardrail system (PCGS) providing stability (up to the initial 4 m) to the perpendicular connected PCGS section

3.3 counterweight

mass used to resist overturning and/or sliding

3.4 duty holder

person or organization with the responsibility for the overall standard and quality of the PCGS

NOTE The duty holder can also be the owner or client.

3.5 end assembly

assembly that can include counterweights, a post, and connections to the principal and intermediate rails at each end of a PCGS

3.6 intermediate guardrail

rail or continuous element between the principal guardrail and the working surface

3.7 intermediate support

support located between end supports to reduce the span of the principal and intermediate rails of a PCGS

NOTE It includes a post, counterweights, and connections to the principal and intermediate rails and might require fewer counterweights than end supports.

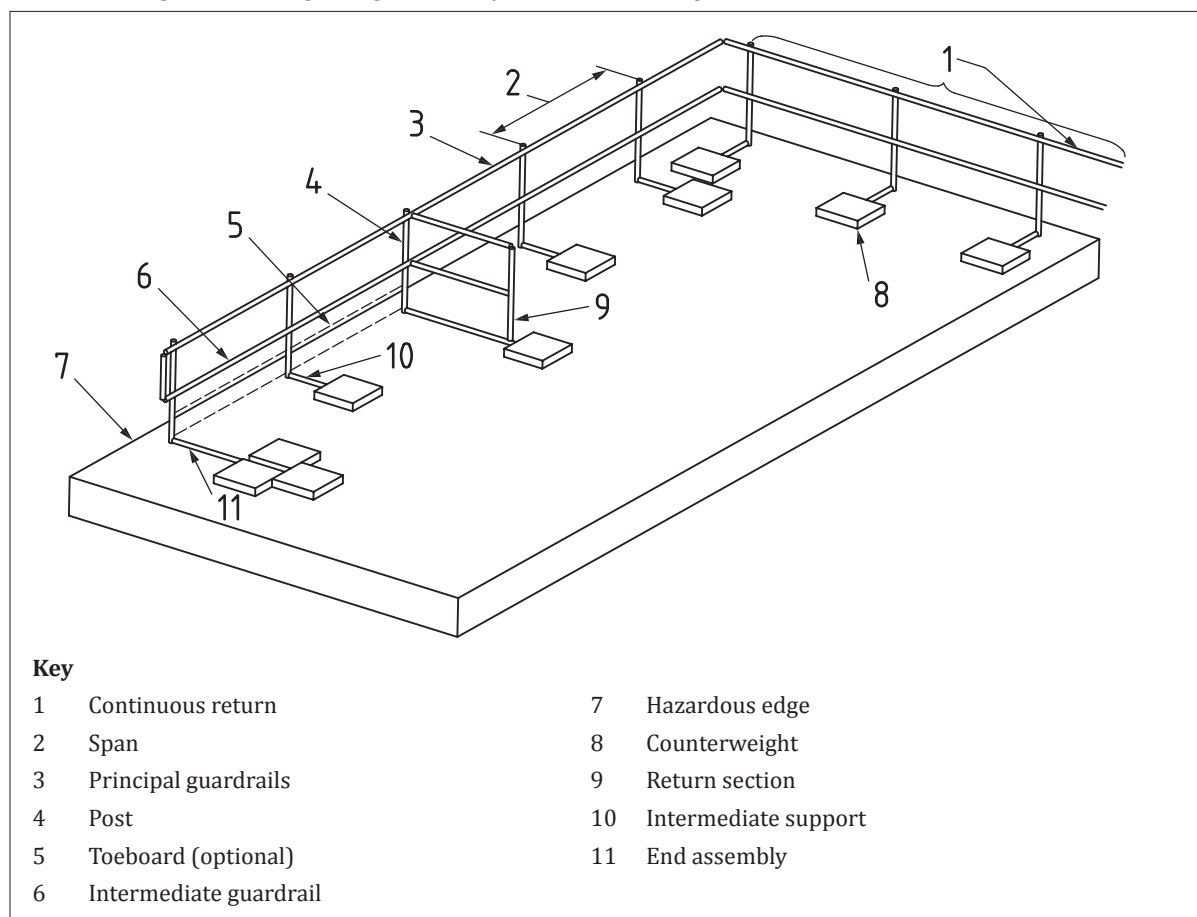
3.8 permanent counterweighted guardrail system (PCGS)

assembled collective fall-protection system protecting a worker from a fall hazard and consisting of at least one span and, if needed, the following free-standing guardrail components:

- a) end assemblies;
- b) intermediate assemblies;
- c) return section(s); and
- d) counterweights

NOTE See [Figure 1](#).

Figure 1 — Free-standing counterweighted guardrail system – PCGS components



3.9 post

principal vertical support of the edge protection system to which the guardrails and toeboards are attached

3.10 principal guardrail

rail or continuous element(s) forming the top of the edge protection system, the uppermost horizontal rail of a PCGS

3.11 return section

intermediate support of a PCGS that can consist of principal and intermediate rails and counterweights

NOTE The return section is perpendicular to the hazardous edge and may be positioned at any point along the length of the (PCGS), however, if the return section is positioned at the end of the (PCGS) and forms a ninety degree return it cannot be considered as fall protection (see [Figure 12](#)).

3.12 span

unsupported length between any pair of adjacent supports

3.13 toeboard (optional)

upstanding element provided specifically to prevent materials or persons from falling or sliding off a surface

4 General requirements

4.1 General

Unless otherwise stated in this British Standard, all units shall have a tolerance range of $\pm 2\%$.

4.2 Materials

4.2.1 General

All materials shall conform to relevant European Standards, where design data is provided.

NOTE 1 If European Standards do not exist, ISO Standards can be applied.

Materials shall be sufficiently robust and durable to withstand normal working conditions.

Materials shall be free from any impurities and defects which might affect their use.

NOTE 2 Information about the most commonly used materials is given in BS EN 12811-2.

When materials are used whose properties in relation to the intended application (e.g. temperature, ageing, UV-degradation) are not given in any available standard, an assessment shall be carried out in accordance with this British Standard.

Couplers and tubes shall be tested and proven for function and conformity to BS EN 74 (all parts), BS EN 39 and [BS 1139-1.2](#).

4.2.2 Steel

Steels of deoxidation type FU (rimming steels) shall not be used.

NOTE Information on common types of corrosion protection is given in BS EN 12811-2.

4.2.3 Timber

Timber shall be strength graded in accordance with BS EN 338 to have a minimum classification of C16.

If a protective coating is used, it shall not impede the visual inspection of the material.

Plywood shall have be durable in relation to climatic conditions.

4.2.4 Material for counterweights

Materials used shall be solid and able to operate within a temperature range of $-20\text{ }^{\circ}\text{C}$ to $60\text{ }^{\circ}\text{C}$.

Granulated or fluid materials such as sand or water shall not be used.

Each counterweight shall be capable of being positively secured against accidental displacement.

4.3 Non-metallic materials

Non-metallic materials that can be degraded by exposure to sunlight or other environmental conditions shall be protected against such degradation by shielding or other suitable means, confirmed by a declaration of conformity issued by the manufacturer.

4.4 Fasteners

Fasteners used as part of the PCGS shall not create a combination of metals that could cause an adverse galvanic reaction. This shall be confirmed by a declaration of conformity issued by the manufacturer.

All fasteners connecting counterweights and railings or railing elements shall be rated for the applied loads.

4.5 Drainage

All components shall be free draining and prevent adverse water accumulation within the rail, the post, and counterweight components.

4.6 Finish

The finish of all components of the PCGS shall be free of deposits (e.g. scale, rust) of foreign matter other than applied protective coatings, and free of sharp edges.

4.7 Welded assembly

Welding shall be carried out in accordance with BS EN ISO 3834-1.

5 Design requirements

5.1 General

If not otherwise specified, the design shall be in accordance with the limit state method. All loads specified in this British Standard shall be considered as characteristic loads.

Design shall be carried out in accordance with the European Standards for structural engineering, including:

- a) For steel: NA to BS EN 1993, part 1-1 to 1-6;
- b) For aluminium: NA to BS EN 1999, part 1-1 to 1-5;
- c) For timber: NA to BS EN 1995, part 1-1 and 1-2; and
- d) For design: BS EN 1990.

The PCGS, as well as each component, shall fulfil the individual load requirements separately.

The design shall take into account the PGCS and its components.

NOTE Static load requirements can be verified by calculation or testing.

5.2 Configuration

The principal guardrail height shall be a minimum of 1 100 mm from the top of the principal guardrail to the walking surface.

Intermediate guardrails shall be located so that the gap between any two rails does not exceed 470 mm.

The gap between the lowest intermediate rail and the walking surface shall not exceed 530 mm.

NOTE 1 In some cases, the addition of a toeboard may be required to maintain the 470 mm gap between the lowest intermediate rail and working surface during construction operations. Attention is drawn to the Temporary Works Directive [1].

NOTE 2 In many cases, a toeboard is not required if a similar/comparable feature exists.

NOTE 3 There can be instances that require two or more intermediate rails.

Cantilevered sections of railing at the ends or corner shall not extend more than 500 mm beyond the vertical post.

5.3 Counterweights

All components of the PCGS shall be secured to resist forces in any direction so that they do not release under the usage for which the system has been designed.

5.4 Partial safety factors

The structural design shall be such that the structure is in accordance with the following requirements:

- a) ultimate limit state with fundamental loads, including load bearing capacity and stability against sliding, overturning and uplift;
- b) ultimate limit state with accidental loads: load bearing capacity for non-intended loads, e.g. from people climbing on the edge protection; and
- c) serviceability limit state: elastic deflection of the edge protection.

5.4.1 Ultimate limit state with fundamental loads

NOTE See [Clause 6](#) for test requirements.

Calculations for the ultimate limit state with fundamental loads shall be:

- a) $\gamma_F = 0.9$ for favourable loads, e.g. counterweight when calculating the stability of counterweighted protection;
- b) $\gamma_F = 1.5$ for all permanent and variable loads;
- c) $\gamma_M = 1.1$ for ductile metallic materials (ductility limits are given in BS EN 12811-2);
- d) $\gamma_M = 1.25$ for brittle metallic materials; and
- e) $\gamma_M = 1.3$ for timber.

5.4.2 Serviceability limit state

NOTE See [Clause 6](#) for test requirements.

Calculations for the serviceability limit state shall be:

- a) $\gamma_F = 1.0$; and
- b) $\gamma_M = 1.0$.

5.4.3 Ultimate limit state with accidental loads

NOTE See [Clause 6](#) for test requirements.

Calculations for the ultimate limit state with accidental loads shall be:

- a) $\gamma_F = 1.0$; and
- b) $\gamma_M = 1.0$.

6 Test requirements

6.1 General

Test requirements shall be in accordance with [Table 1](#) and the specific requirements of [6.2](#) to [6.7](#).

Table 1 — *Test requirements – Overview*

Designation	Figure and Table Title	Description	Reference
F_{T1}	Horizontally outwards – guardrails and posts	Perpendicular to the edge protection in the outwards direction acting on the guardrails and posts.	Table 2 Figure 2
F_{H1}		Perpendicular to the edge protection system in the outward direction acting on the guardrails and posts.	
F_{T2}	Horizontally outwards – toeboards (optional)	Perpendicular to the edge protection in the outwards direction acting on the toeboards.	Table 3 Figure 3
F_{H2}		Perpendicular to the edge protection system in the outward direction acting on the toeboards.	
F_{T1}	Vertically downwards – Guardrails and posts	Downwards parallel to the edge protection system acting on the guardrails and posts.	Table 4 Figure 4
F_D		Downwards parallel to the edge protection system acting on the guardrails and posts.	
F_{T2}	Vertically downwards – Toeboard (optional)	Downwards parallel to the edge protection system acting on the toeboards.	Table 5 Figure 5
F_D		Downwards parallel to the edge protection system acting on the toeboards.	
F_{H3}	Horizontally parallel – Guardrails and posts	Parallel to the edge protection system along its length acting on the guardrails and posts.	Table 6 Figure 6
F_{H3}	Horizontally parallel – Toeboard (optional)	Parallel to the edge protection system along its length acting on the toeboards.	Table 7 Figure 7
F_{UP}	Vertically upwards – System	Upwards parallel to the edge protection system acting on the principal guardrail.	Table 8 Figure 8
$F_{H1} + F_{WW}$	Working wind – Horizontally outwards – guardrails and post (principal guardrail only)	Perpendicular to the edge protection system in the outward direction acting on the guardrails and posts. Working wind converted to a point load.	Table 9 Figure 9
$F_{H1} + F_{WW}$	Working wind – Horizontally outwards – toeboard	Perpendicular to the edge protection system in the outward direction acting on the toeboards. Working wind converted to a point load.	Table 10 Figure 10

6.2 Static tests

A PCGS, when tested in accordance with [7.3](#), shall resist the test point static loads and requirements in accordance with [Table 2](#), [Table 3](#), [Table 4](#), [Table 5](#), [Table 6](#), [Table 7](#), [Table 9](#) and [Table 10](#).

NOTE 1 See also [Figure 2](#), [Figure 3](#), [Figure 4](#), [Figure 5](#), [Figure 6](#), [Figure 7](#), [Figure 8](#), [Figure 9](#) and [Figure 10](#).

When the upward force, as specified in [Table 8](#) is applied, no part of the system shall become detached.

NOTE 2 See also [Figure 8](#).

Where there is more than one intermediate rail, tests shall to be applied to each intermediate rail in accordance with [Table 2](#), [Table 4](#) and [Table 6](#).

NOTE 3 See also [Figure 2](#), [Figure 4](#) and [Figure 6](#).

A minimum of four separate representative samples shall be tested for all tests in this clause.