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Steel and aluminium rainwater systems – Specification

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Contents

Summary of pages

This document comprises a front cover, an inside front cover, pages i to ii, pages 1 to 40, an inside back cover and a back cover.

Foreword

Publishing information

This British Standard is published by BSI Standards Limited, under licence from The British Standards Institution, and came into effect on 31 January 2017. It was prepared by Subcommittee B/542/6, *Corrugated sheeting materials*, under the authority of Technical Committee B/542, *Roofing and cladding products for discontinuous laying*. A list of organizations represented on these committees can be obtained on request to their secretary.

Relationship with other publications

Harmonization of European Standards resulted in the withdrawal of the British Standards for aluminium rainwater goods, BS 2997:1958, and steel rainwater goods, BS 1091:1963, leaving the UK with no standards for its generic types of steel and aluminium gutter and rainwater pipe systems.

This British Standard covers UK metal gutter and rainwater pipe systems excluded from the scopes of BS EN 612 and BS 8530.

Use of this document

Two methods of testing gutter strength are permitted by this British Standard: finite element analysis (Annex A) and physical testing (Annex B), to avoid limiting user's testing options. These are equivalent methods of testing.

Presentational conventions

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.

Contractual and legal considerations

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a British Standard cannot confer immunity from legal obligations.

1 Scope

This British Standard specifies requirements for the design and manufacture of metal gutters and pipes intended to drain rainwater from buildings. It specifies the materials, tolerances, mechanical properties and surface conditions, coatings, laminated surfaces, jointing methods and fixings for rainwater systems, including fittings and accessories for assembly or support.

2 Normative references

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

Standards publications

BS 1474, *Specification for wrought aluminium and aluminium alloys for general engineering purposes: bars, extruded round tubes and sections* [1)]

BS 8530, *Traditional-style half round, beaded half round, Victorian ogee and moulded ogee aluminium rainwater systems – Specification*

BS EN 485-2:2016, *Aluminium and aluminium alloys – Sheet, strip and plate – Part 2: Mechanical properties*

BS EN 681-1, *Elastomeric seals – Material requirements for pipe joint seals used in water and drainage applications – Part 1: Vulcanized rubber*

BS EN 755-2, *Aluminium and aluminium alloys – Extruded rod/bar, tube and profiles – Part 2: Mechanical properties*

BS EN 755-3, *Aluminium and aluminium alloys – Extruded rod/bar, tube and profiles – Part 3: Round bars, tolerances on dimensions and form*

BS EN 755-4, *Aluminium and aluminium alloys – Extruded rod/bar, tube and profiles – Part 4: Square bars, tolerances on dimensions and form*

BS EN 755-5, *Aluminium and aluminium alloys – Extruded rod/bar, tube and profiles – Part 5: Rectangular bars, tolerances on dimensions and form*

BS EN 755-7, *Aluminium and aluminium alloys – Extruded rod/bar, tube and profiles – Part 7: Seamless tubes, tolerances on dimensions and form*

BS EN 755-9, *Aluminium and aluminium alloys – Extruded rod/bar, tube and profiles – Part 9: Profiles, tolerances on dimensions and form*

BS EN 10025 (all parts), *Hot rolled products of structual steels*

BS EN 10088-1, *Stainless steels – Part 1: List of stainless steels*

BS EN 10111, *Continuously hot rolled low carbon steel sheet and strip for cold forming – Technical delivery conditions*

BS EN 10152:2009, *Electrolytically zinc coated cold rolled steel flat products for cold forming – Technical delivery and conditions*

BS EN 10346, *Continuously hot-dip coated steel flat products for cold forming – Technical delivery conditions*

BS EN 12056 (all parts), *Gravity drainage systems inside buildings*

BS EN 12056-3, *Gravity drainage systems inside buildings – Part 3: Roof drainage, layout and calculation* [2)]

[1)] Withdrawn.
[2)] This standard gives informative references to BS EN 10256-3:2000.

BS EN 13523 (all parts), *Coil coated metals – Test methods*

BS EN ISO 544, *Welding consumables – Technical delivery conditions for filler materials and fluxes – Type of product, dimensions, tolerances and markings*

BS EN ISO 1461, *Hot dip galvanized coatings on fabricated iron and steel articles – Specifications and test methods*

BS EN ISO 11600:2003+A1:2011, *Building construction – Jointing products – Classification and requirements for sealants*

Other publications

[N1] NATIONAL FEDERATION OF ROOFING CONTRACTORS LIMITED (NFRC). Technical Bulletin 36: *Performance Standards for Butyl Strip Sealants in Metal Clad Buildings*. London: NFRC, June 2003.

3 Terms and definitions

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

3.1 accessories
rivets, bolts, nuts, washers and screws for fixing gutters and pipes to a building

3.2 angle
corner component which changes the direction of the gutter

3.3 boundary (or parapet) wall gutter
gutter positioned against the vertical internal face of a perimeter parapet wall

3.4 cast aluminium
type of aluminium made by pouring molten aluminium into a mould form

3.5 extruded aluminium
linear shaped aluminium profile formed by forcing a preheated softened aluminium mass under extreme pressure through a die, the opening of which corresponds to the required cross-sectional profile

3.6 fitting <gutter>
angle, outlet, stop end or double socket/spigot joint union for use with gutters

3.7 fitting <pipe>
shoe, offset (double bend), bend, branch, loose socket, pipe clip or hopper head for use with pipes

3.8 fittings and accessories for assembly or support
gutter joint unions, corner pieces, rainwater outlets, end caps and support brackets to create a complete gutter installation

3.9 Gutters

3.9.1 gutter
open channel which collects and evacuates rainwater from a roof area

3.9.2 eaves gutter
gutter fitted to the edge of a roof to the external face of a building

3.9.3 inboard gutter
gutter that is internal to the building fabric

NOTE These include valley, boundary wall, inplane roof and enclosed eaves gutters.

3.9.4 outboard gutter
gutter that is external to the building fabric

NOTE These gutters are exterior of the building envelope and supported on one side.

3.9.5 valley gutter
gutter positioned at the base of two sloping roofs

3.10 Gutter brackets

3.10.1 fascia bracket
gutter bracket suitable for fixing to a surface which runs parallel to the building

3.10.2 gutter bracket
item for retaining/supporting a gutter to a building

3.10.3 purlin valley bracket
gutter bracket hooked over two parallel roof support members forming a cradle to carry a valley gutter

3.10.4 rise and fall bracket
gutter bracket assembly for fixing into masonry below the gutter, which provides height adjustment via a vertical bar connected to the gutter support cradle

3.10.5 side/top rafter bracket
gutter bracket suitable for fixing to the side or top of a roof rafter

3.11 gutter sole
horizontal base section of gutter

NOTE Also taken to refer to the width across the horizontal base section measured perpendicular to the gutter run.

3.12 Joints

3.12.1 joint
connection between the ends of gutters, fittings or pipes

3.12.2 joggle joint
gutter jointing method whereby a jointing sleeve with holes along one edge to facilitate mechanical fixing is factory welded or fabricated to the end of a gutter section, allowing a bolted joint to be made to another gutter section

3.12.3 socket joint
end of an external profile of gutter or pipe enlarged to allow another section of pipe or gutter to be placed inside the enlarged area forming a joint between sections

3.12.4 spigot joint
end of an external profile of gutter or pipe proportionately reduced in size to allow the reduced end to be placed into a gutter or pipe to form a joint

3.13 nominal size DN
alphanumerical designation of size for components of a pipework system, which is used for reference purposes

NOTE The nominal size comprises the letters DN followed by a dimensionless whole number which is indirectly related to the physical size, in millimetres, of the bore or outside diameter of the end connections.

3.14 patch outlet/roof outlet
preformed flanged rainwater outlet which is mechanically fixed and sealed to the inside or outside of a flat or non-flat base gutter to drain rainwater from the gutter

3.15 pipe
tube of uniform bore, straight in axis, having either a spigot or socket connector facility, or plain ended for connection with a separate connector

3.16 PPC
electrostatically applied polyester powder coating painting method

3.17 press-formed sheet steel/aluminium gutter system
gutter made from flat sheet metal/aluminium machine formed to a given longitudinal shape

3.18 protective coating
coating or system applied to a corrosive metal substrate to prevent or reduce corrosion

EXAMPLE

Galvanizing to BS EN ISO 1461 or electroplated zinc coating to BS EN ISO 2081

3.19 rainwater system
above ground system for the conveyance of rainwater from a building

3.20 sheet steel or aluminium
flat piece of steel or aluminium manufactured from molten steel or aluminium, formed when metal is passed through pinch rollers to reduce the material to required thickness

3.21 weir overflow
opening or outlet pipe positioned below the overflow level of the gutter to act as a gutter outlet blockage warning indicator

4 Gutters

COMMENTARY ON CLAUSE ***4***

Many press-formed sheet steel gutter systems are manufactured to bespoke dimensions and profiles. It is therefore not possible to tabulate the required material thickness for all developed widths of gutters as the structural integrity is affected by various factors, such as profile, support method, bonded insulation materials. Also, valley and boundary wall gutters need to allow, where appropriate, for the additional load of pedestrian traffic for roof maintenance purposes.

Therefore, unless the required gutter design conforms to performance criteria when tested in accordance with Annex A (FEA) or Annex B (physical testing), the design needs to be supported by calculations as set out in Annex A or by independently certified test results to prove fitness for purpose.

4.1 The gutter dimensions and profiles necessary to achieve the required hydraulic performance shall be designed in accordance with BS EN 12056-3.

4.2 When a gutter system comprising the combination(s) of components in Table 1 to Table 6 appropriate for the anticipated application (e.g. type of building, such as industrial) and service design life (see BS 7543) is:

a) subjected to the maximum applied service loads in accordance with Annex A (FEA test method):
   1) the reported stress shall be less than the yield strength of the material (see Table A.4);
   2) for inboard gutters, the reported deflection shall not exceed gutter sole width divided by 50 (L/50) (see Table A.4); and
   3) for outboard gutters, the reported deflection shall not exceed gutter sole width divided by 20 (L/20) (see Table A.4); or
b) subjected to the maximum applied safety loads + 1.5 (factor of safety) in accordance with Annex B (physical test method), the reported stress shall be less than the maximum tensile strength of the material (see Table B.1).

4.3 The gutters to be tested to the requirements of **4.2** shall be selected based on the following parameters.

a) For each gutter shape range, the largest gutter in the range shall be tested. If thinner material is used for smaller gutters in a range, then in addition to the largest gutter in the range, the largest gutter for any material thickness shall be tested.
b) Any bespoke gutters falling outside the normal manufacturer's range shall be tested.

4.4 Where FEA methods are to be used, the two standard benchmark test cases in A.1 shall first be run using the FEA set-up and the results confirmed to be within ±5% of benchmark figures. The same procedures and set-up shall then be used for testing all the products to be tested by FEA.

Table 1 **Gutter material and protective/decorative coatings**

Material	**Weather protection coating**	**Decorative coating**
Mild steel sheet, coil or strip conforming to BS EN ISO 1461, BS EN 10025 or BS EN 10111 for galvanizing after manufacture	Black bitumen PVC/TPO/PPC coating	PPC Wet paint
Pre-galvanized sheet, coil or strip conforming to BS EN 10346	Black bitumen or PVC/TPO/ pre- or post-laminated membrane Self-finish	PPC Wet paint
Stainless steel sheet, coil or strip conforming to BS EN 10088-1	Self-finish	None
Plastisol-coated steel conforming to BS EN 13523	Double-sided self-finish or bitumen	Self-finish
Electro-zinc coated steel sheet conforming to BS EN 10152:2009, DC01+ZE 25/25	Black bitumen or PVC/TPO/PPC coating	PPC wet paint
Aluminium sheet of alloy 1050A H14, BS EN 485-2:2016	Self-finish	PPC Wet finish
Extruded aluminium to BS EN 755-2, BS EN 755-3, BS EN 755-4, BS EN 755-5, BS EN 755-7, BS EN ISO 544, BS 1474 [3)]	Self-finish	PPC Wet finish anodized
Cast aluminium to BS 8530	Self-finish	PPC Wet finish

[3)] Withdrawn.

Table 2 **Example gutter types**

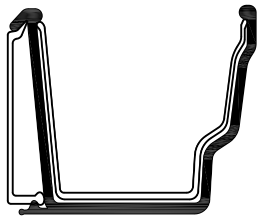
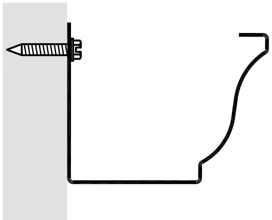
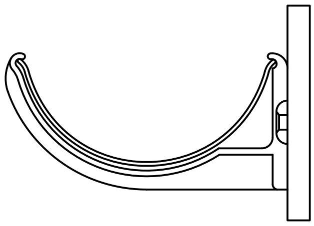
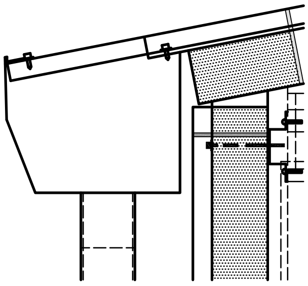
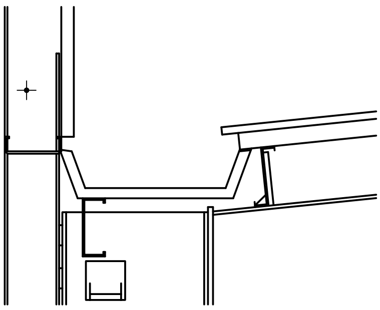
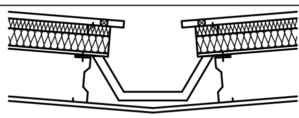
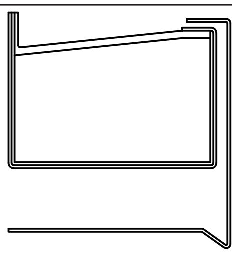
Type	Drawing
Outboard gutters	
Concealed fixed eaves gutter	
Direct fixed eaves gutter	
Eaves gutter with fascia bracket	
Trimline eaves gutter (top hung)	
Inboard gutters	
Boundary wall/parapet gutter	
Valley gutter	
Enclosed eaves gutter	

Table 3 **Joints: Connection, sealants, fixings and expansion** *(1 of 2)*

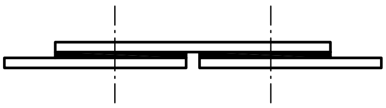
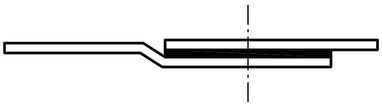
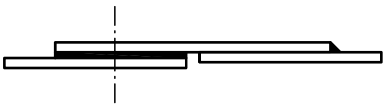
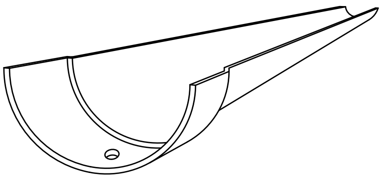
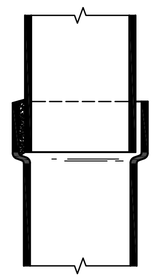
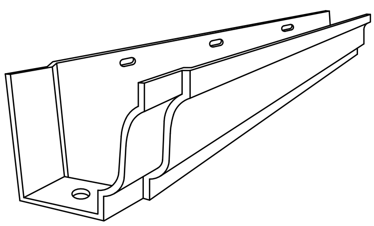
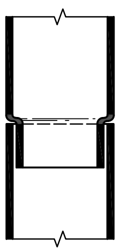
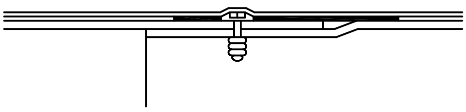
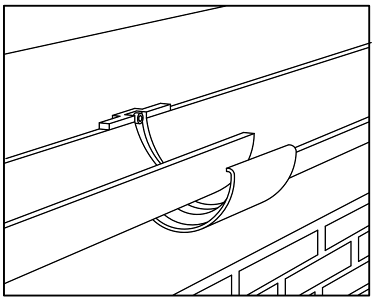
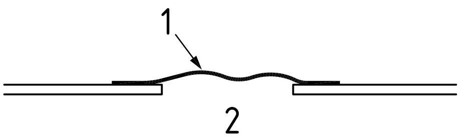
Connection type	Fixing type	Sealant
Loose butt strap joint: 	Captive nuts/rivets/studs Stainless self-drilling screws compatible with the gutter material substrate	Gun-applied, high-performance, low modulus silicone conforming to BS EN ISO 11600:2003+A1:2011; Butyl strip sealant of Class A classification as published in the NFRC Technical Bulletin 36 (June 2003) [N1]; or Compressed EPDM rubber seal strips conforming to BS EN 681-1
Joggle joint: 	Captive nuts/rivets/studs Stainless self-drilling screws compatible with the gutter material substrate	
Welded butt strap joint: 	Captive nuts/rivets/studs Stainless self-drilling screws compatible with the gutter material substrate	
Socket (gutter): 	Nuts and bolts/rivets compatible with the gutter material substrate	
Socket (pipe): 	No joint fixing required	
Spigot (gutter): 	Nuts and bolts/rivets compatible with the gutter material substrate	
Spigot (pipe): 	No joint fixing required	

Table 3 **Joints: Connection, sealants, fixings and expansion** *(2 of 2)*

Connection type	Fixing type	Sealant
Membrane joint: 	PVC/TPO membrane, incorporating mechanical fixing and aluminium foil tape	
Compression or snap fit gutter joint: 	No mechanical fixing	
Expansion joint:  **Key** 1 Flexible material bonded to gutter, both sides of joint 2 Gap in solid gutter to allow movement	Proprietary fixed per manufacturer's instructions	

NOTE 1 Consideration to be given to bimetallic corrosion from dissimilar materials. Guidance on corrosion at bimetallic contacts is given in PD 6484.

NOTE 2 For internal gutters, insulation can be used. Note that the gutter does not have a U value; it has a Ψ value to provide a thermal transmittance to permit ice in the gutter to melt before that on the remainder of the roof area.

Table 4 **Gutter support: Connectivity to the frame, brackets, fascia fix** *(1 of 2)*

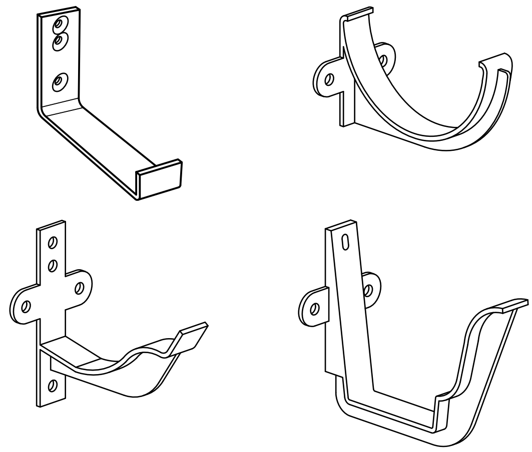
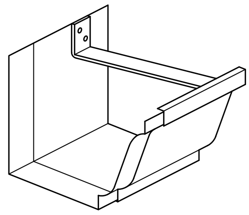
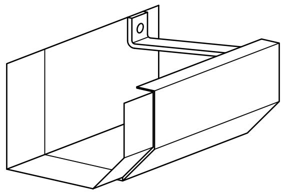
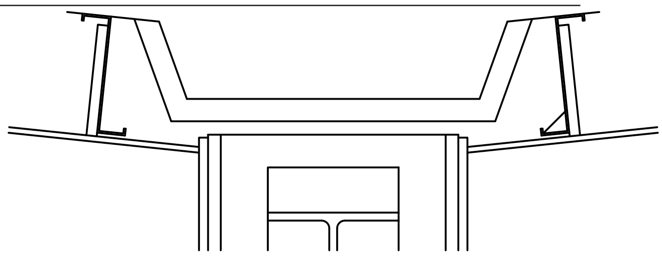
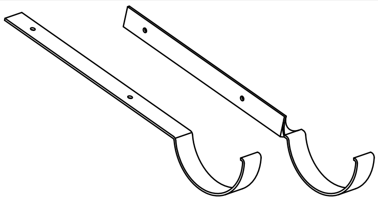
Support type	Illustration
Fascia bracket	
Internal cross-brace	
Direct-fix 1: Eaves	
Direct-fix 2: Purlin	
Side/top rafter bracket	

Table 4 **Gutter support: Connectivity to the frame, brackets, fascia fix** *(2 of 2)*

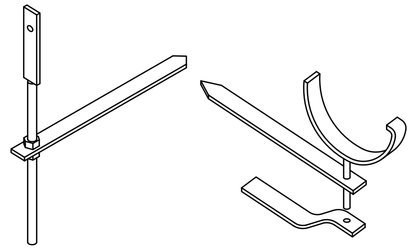
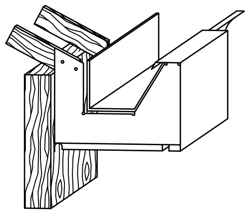
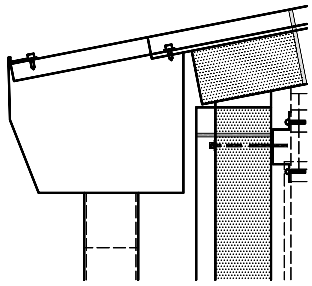
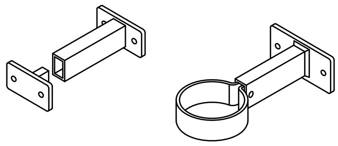
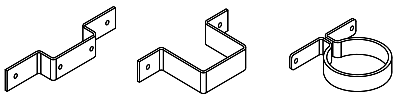
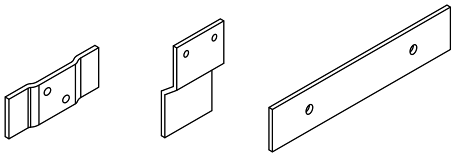
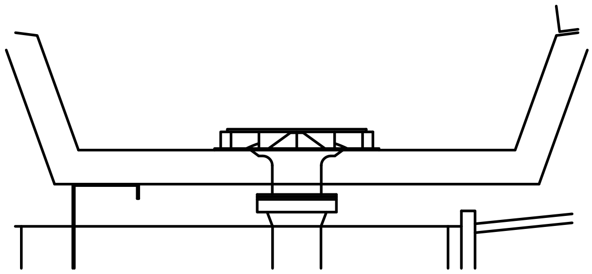
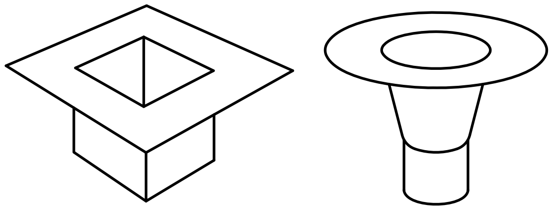
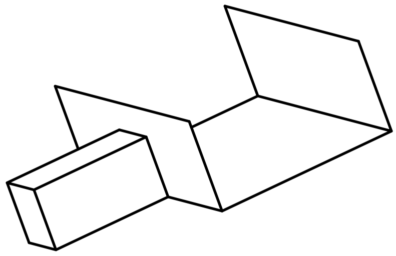
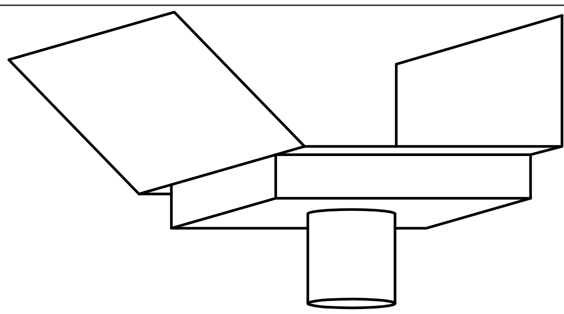
Support type	Illustration
Rise and fall bracket	
Web bracket Cradle bracket	
Top hung form roof sheet (trimline gutter)	
Extension pipe brackets, pipe clips, concealed pipe clips	
Clips	
Concealed fixings	

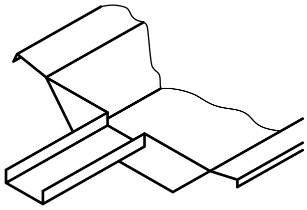
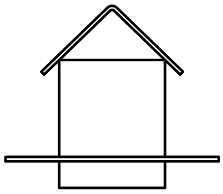
Table 5 **Rainwater outlets: Siphonic, patch and downpipes**

Outlet type[A)]	Drawing
Siphonic outlet to BS EN 12056	 *NOTE Drawing is of a generic form of siphonic outlet.*
Vertical gravity outlet to BS EN 12056	
Horizontal gravity outlet to BS EN 12056 [B)]	
Sump in gutter to improve outlet performance	

[A)] Gutter outlets shall be installed in accordance with the manufacturer's instructions to maintain the structural integrity of the system.

[B)] Not recommended where avoidable in BS EN 12056 due to lower capacity. Should only be used where building structure prevents the use of vertical outlets.

Table 6 **Warning indicators**

Indicator	Illustration	Notes
Weir overflow		BS EN 12056
Periscope overflow/Witch's hat		

Annex A (normative) Gutter stress test: Finite element analysis

A.1 Benchmark testing

A.1.1 Principle

Benchmark testing is conducted to allow the FEA user to check their set-up against known values, and thus ensure all settings are correct in the FEA software being used for **A.3** to **A.7**.

A.1.2 Test method

A.1.2.1 The procedures set in **A.3** to **A.7** shall be followed in the sequence set out in **A.2**, to evaluate the test cases in **A.1.3** to **A.1.5**.

A.1.2.2 For the benchmark tests the physical parameters set out in Table A.1 shall be used.

NOTE Table A.1 indicates the physical parameters used in the benchmark tests.

A.1.2.3 Results from the FEA output on the benchmark tests shall be within ±5% of the benchmark values given in Table A.2 (in **A.1.3.2.2**) and Table A.3 (in **A.1.4.2.2**) before testing of other gutters can be undertaken.

Table A.1 **Physical parameters for benchmark tests**

Component	Material	Grade
Box gutter	Aluminium	1050 A
Ply board	Wood	n/a
Bracket 1	Aluminium	6063 T6
Bracket 2	Aluminium	6063 T6
Bracket 3	Aluminium	6063 T6
Self-tapping screw 1	Stainless steel	A2
Self-tapping screw 2	Stainless steel	A2
Self-tapping screw 3	Stainless steel	A2
Welds	Aluminium	6063

A.1.3 Benchmark Test 1: (150 × 100) mm box gutter

A.1.3.1 Principle

This test is based on a common type of folded metal box gutter with internal brackets welded to the front face, and back fixings through the bracket into a solid facia.

A.1.3.2 Benchmark test data

A.1.3.2.1 Physical dimensions

The gutter sample shall have a length of 925 mm, with 3 × 25 mm wide brackets as shown in Figure A.1. The gutter shall have cross-sectional dimensions as shown in Figure A.2.

Figure A.1 **Physical dimensions of test sample**

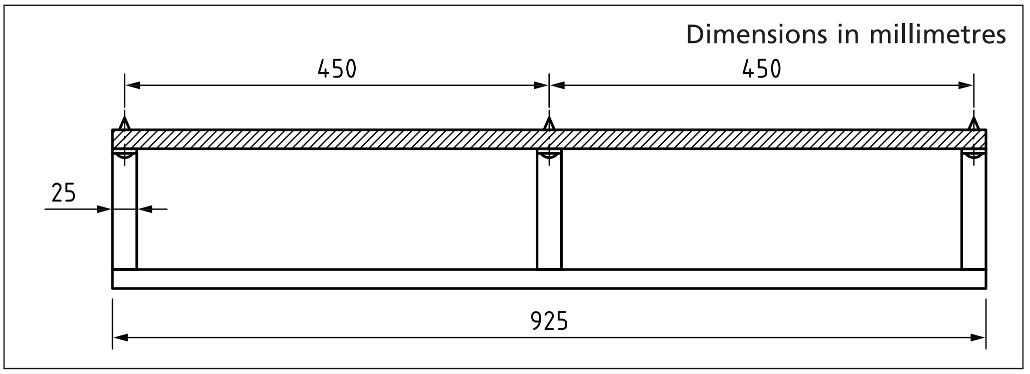
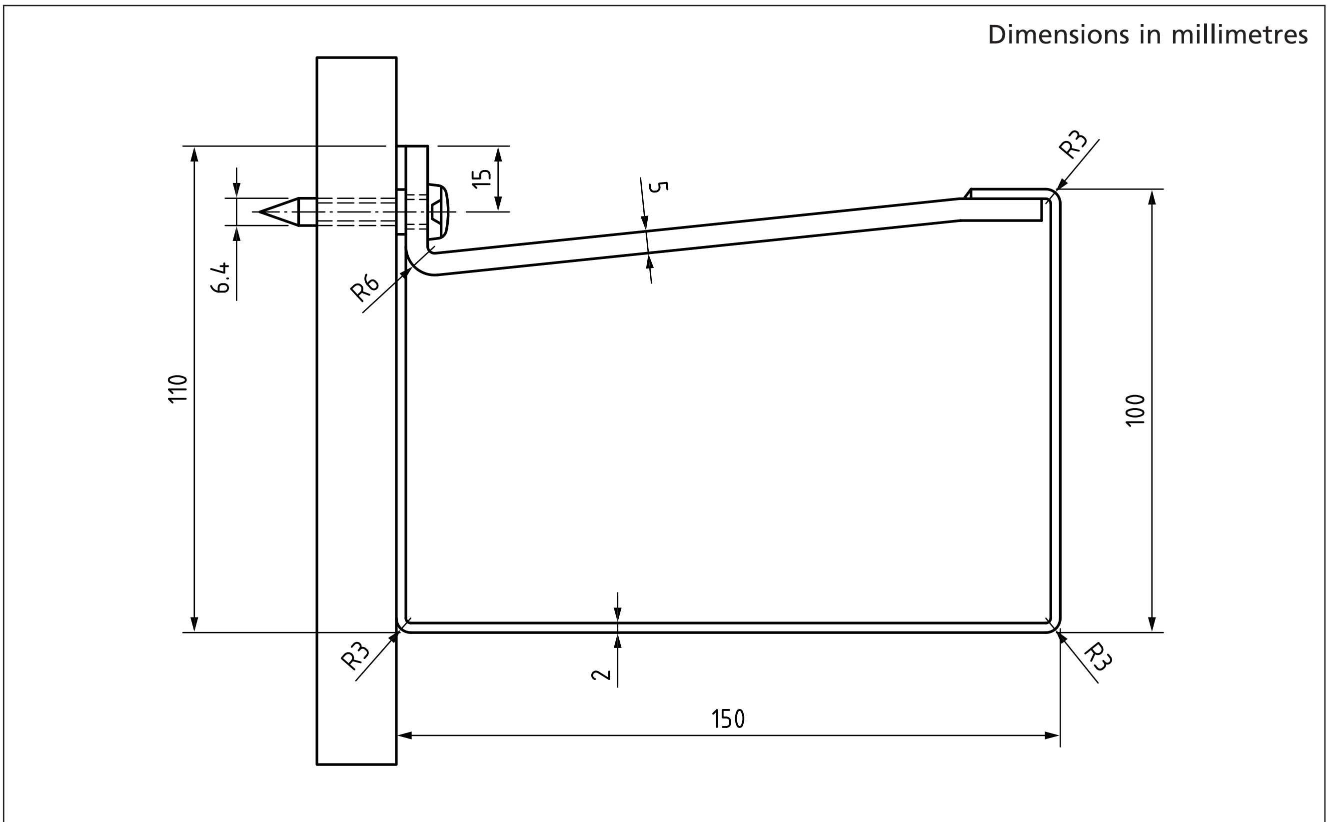


Figure A.2 **Cross-sectional physical dimensions of test sample**

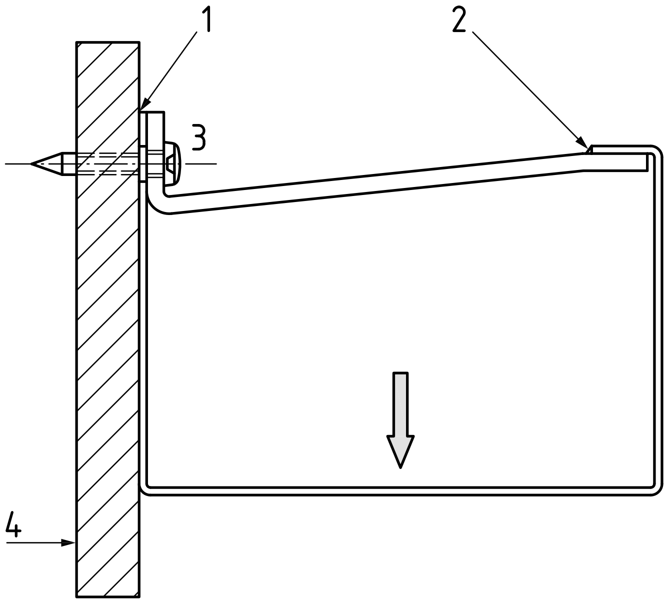


8 mm hole in bracket; 10 mm hole in gutter

A.1.3.2.2 Benchmark water load test

The test shall be carried out in accordance with the method in **A.5**, using the test regime and loadings in Figure A.3 to generate benchmark values. The calculated values shall be compared to and be within ±5% of the target values in Table A.2.

Figure A.3 **Test set-up for water load test on Benchmark Test 1**



Welded joint (bonded)

Calculations:
Max. water depth for gutter length
(150 × 100 × 925) mm of water = 13 kg/m²
Service:
13 kg × 0.009 8 kN = 0.127 kN
Safety:
0.127 × 1.5 = 0.190 kN

Key

1 No connection between gutter and bracket
2 Gutter and bracket connected by weld
3 Fixing point
4 Fixed

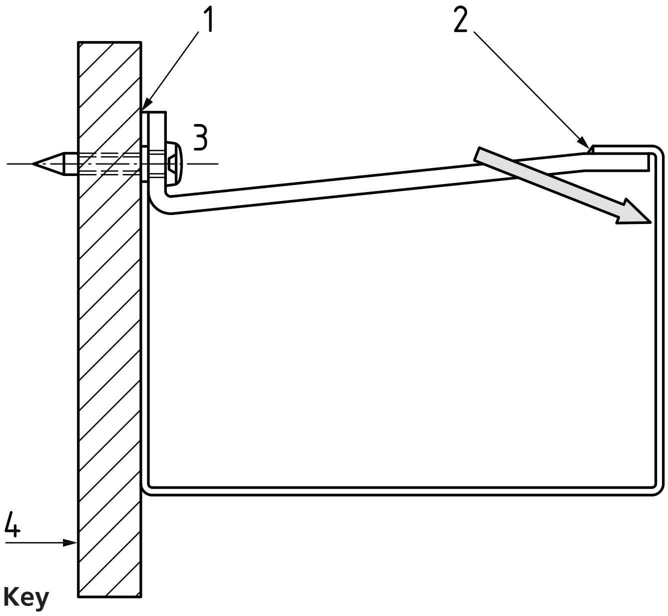
Table A.2 **Deflection results for benchmark tests**

Case	**Reported deflection** mm
Water load service	0.5
Water load safety	0.75
Snow load service	2.8
Snow load safety	4.2
Wind load service	1.8
Wind load safety	2.7

A.1.3.2.3 Benchmark snow load test

The test shall be carried out in accordance with the method in **A.7**, using the test regime and loadings in Figure A.4 to generate benchmark values. The calculated values shall be compared to and be within ±5% of the target values in Table A.2.

Figure A.4 **Test set-up for snow load test on Benchmark Test 1**



Welded joint (bonded)

Calculations:
Gutter length = 0.925 m
Service = 0.700 kN per L/m
0.700 kN × 0.925 m = 0.647 kN applied at 30°
Safety = 1.05 kN per L/m
1.05 kN × 0.925 m = 0.971 kN applied at 30°

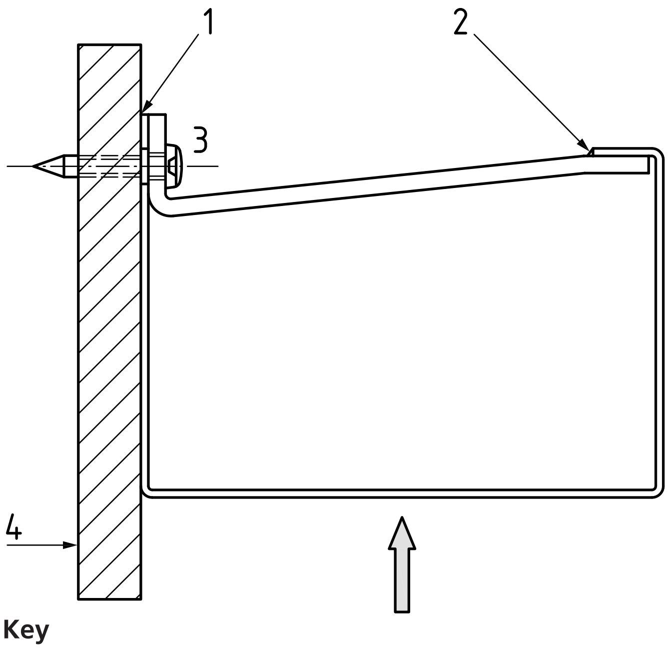
Key

1	No connection between gutter and bracket	3	Fixing point
2	Gutter and bracket connected by weld	4	Fixed

A.1.3.2.4 Benchmark wind load test

The test shall be carried out in accordance with the method in **A.6**, using the test regime and loadings in Figure A.5 to generate benchmark values. The calculated values shall be compared to and be within ±5% of the target values in Table A.2.

Figure A.5 **Test set-up for wind load test on Benchmark Test 1**



Welded joint (bonded)

Calculations:
Gutter length = 0.925 m
Service = 1.74 kN per L/m
150 mm × 1.74 kN = 0.261 kN per L/m
0.261 kN × 0.925 m = 0.241 kN applied
Safety = 2.61 kN per/Lm
150 mm × 2.61 kN = 0.391 kN per L/m
0.391 kN × 0.925 m = 0.361 kN applied

Key

1	No connection between gutter and bracket	3	Fixing point
2	Gutter and bracket connected by weld	4	Fixed

A.1.4 Benchmark Test 2: 150 mm moulded gutter

A.1.4.1 Principle

This test is based on a common type of extruded metal gutter with no internal brackets and back fixings through the rear face into a solid fascia.

A.1.4.2 Benchmark test data

A.1.4.2.1 Physical dimensions

The gutter sample shall have a length of 925 mm, with 3 × fixings as shown in Figure A.6. The gutter shall have cross-sectional dimensions as shown in Figure A.7.

Figure A.6 **Physical dimensions of test sample**

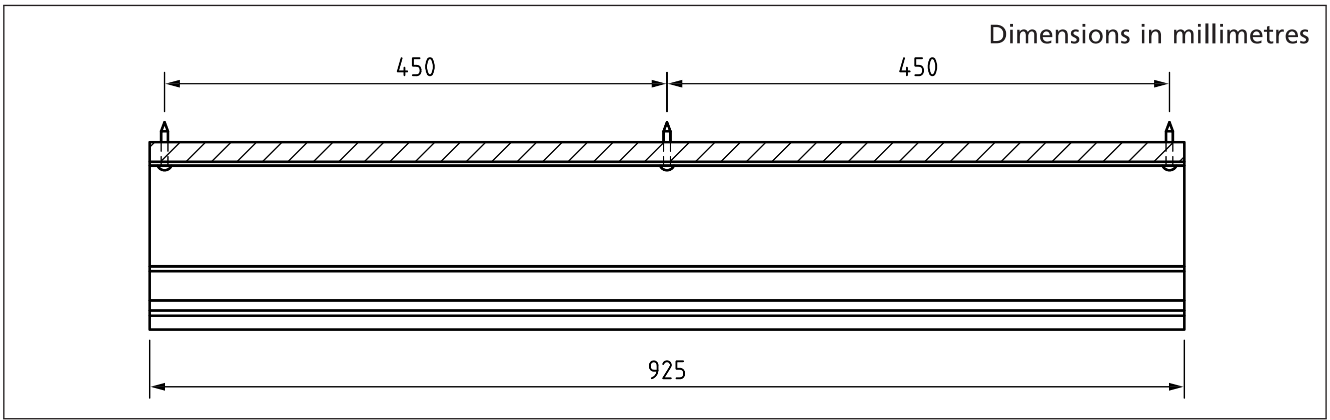
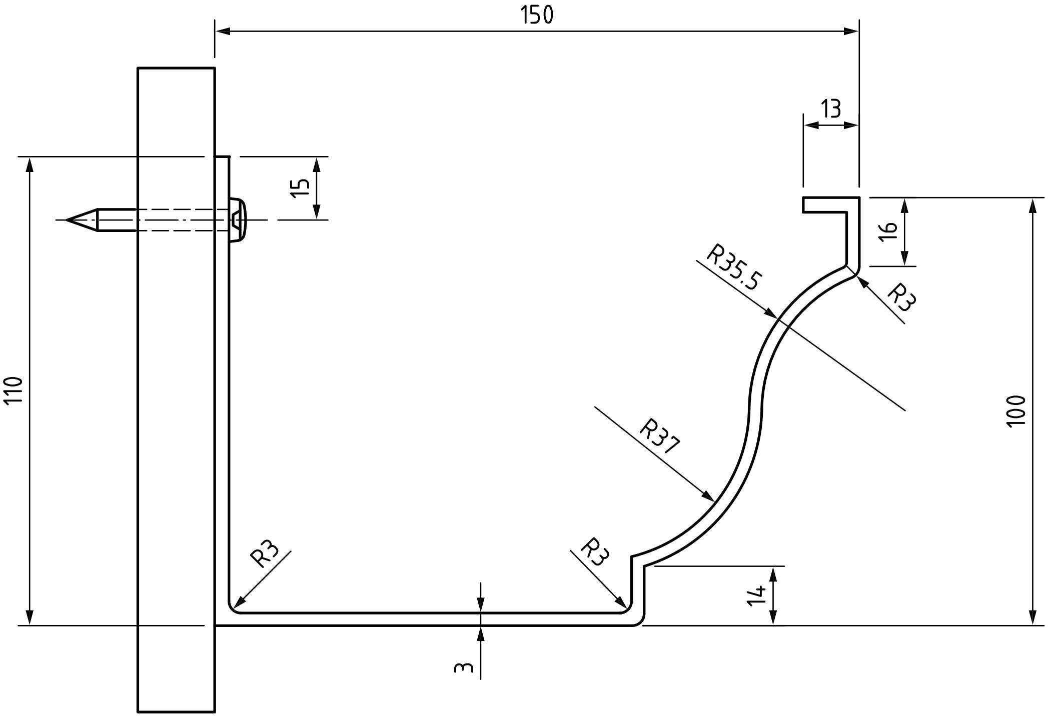


Figure A.7 **Cross-sectional physical dimensions of test sample**

Dimensions in millimetres

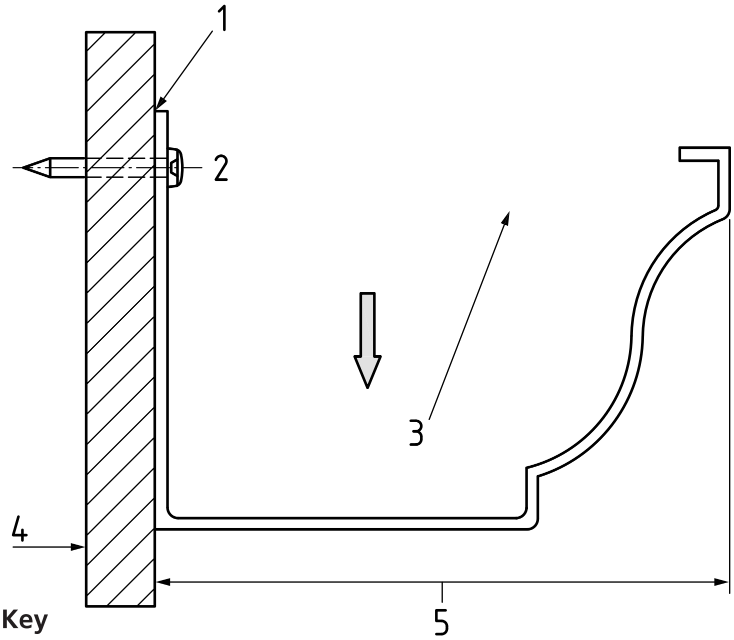


5.5 mm hole in gutter

A.1.4.2.2 Benchmark water load test

The test shall be carried out in accordance with the method in **A.5** using the test regime and loadings in Figure A.8 to generate benchmark values. The calculated values shall be compared to and be within ±5% of the target values in Table A.3.

Figure A.8 **Test set-up for water load test on Benchmark Test 2**



No connection

Calculations:

Max. water depth for gutter length (150 × 100 × 925) mm of water = 10.4 kg/m²

Service:

10.4 kg × 0.009 8 kN = 0.102 kN

Safety:

0.102 kN × 1.5 = 0.153 kN

Key

1 No connection between fascia and bracket
2 Fixing point
3 No brackets
4 Fixed
5 150 mm overall width (extrusion below 160 mm)

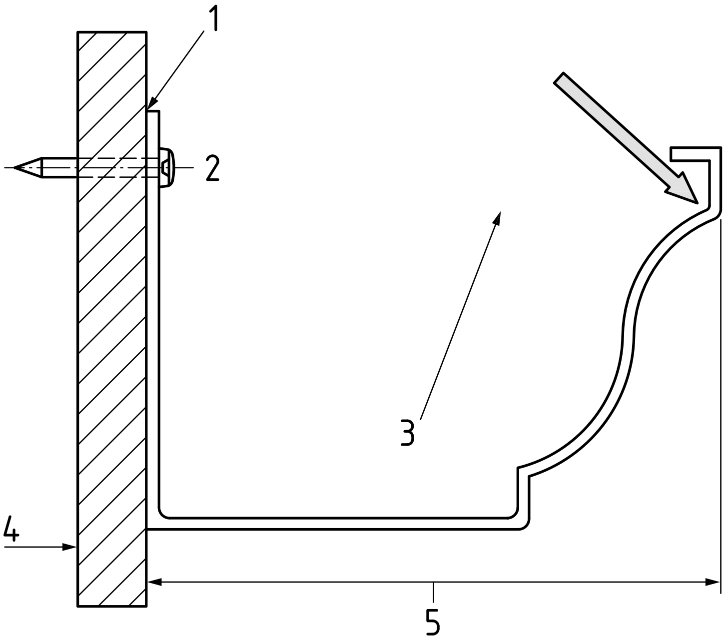
Table A.3 **Deflection results for benchmark tests**

Case	Reported deflection mm
Water load service	0.7
Water load safety	1.1
Snow load service	7.4
Snow load safety	11.1
Wind load service	2.9
Wind load safety	4.3

A.1.4.2.3 Benchmark snow load test

The test shall be carried out in accordance with the method in **A.7**, using the test regime and loadings in Figure A.9 to generate benchmark values. The calculated values shall be compared to and be within ±5% of the target values in Table A.3.

Figure A.9 **Test set-up for snow load test on Benchmark Test 2**



No connection

Calculations:

Gutter length = 0.925 m

Service = 0.700 kN per L/m

0.7 kN × 0.925 m = 0.647 kN applied at 30°

Safety = 1.05 kN per/Lm

1.05 kN × 0.925 m = 0.971 kN applied at 30°

Key

1 No connection between fascia and bracket

2 Fixing point

3 No brackets

4 Fixed

5 150 mm overall width (extrusion below 160 mm)

A.1.4.2.4 Benchmark wind load test

The test shall be carried out in accordance with the method in **A.6**, using the test regime and loadings in Figure A.10 to generate benchmark values. The calculated values shall be compared to and be within ±5% of the target values in Table A.3.

A.1.5 Additional requirements to aid set-up of benchmark gutter analysis

*COMMENTARY ON **A.1.5***

The following notes are designed to help the user set up FEA software to undertake benchmark gutter analysis

A.1.5.1 To set up an accurate FEA test, the gutter, brackets, backgrounds and fixings shall resemble any mechanical connections, such as rivets or screws, and true material properties, i.e. using the manufacturer's specified grade and temper of aluminium.

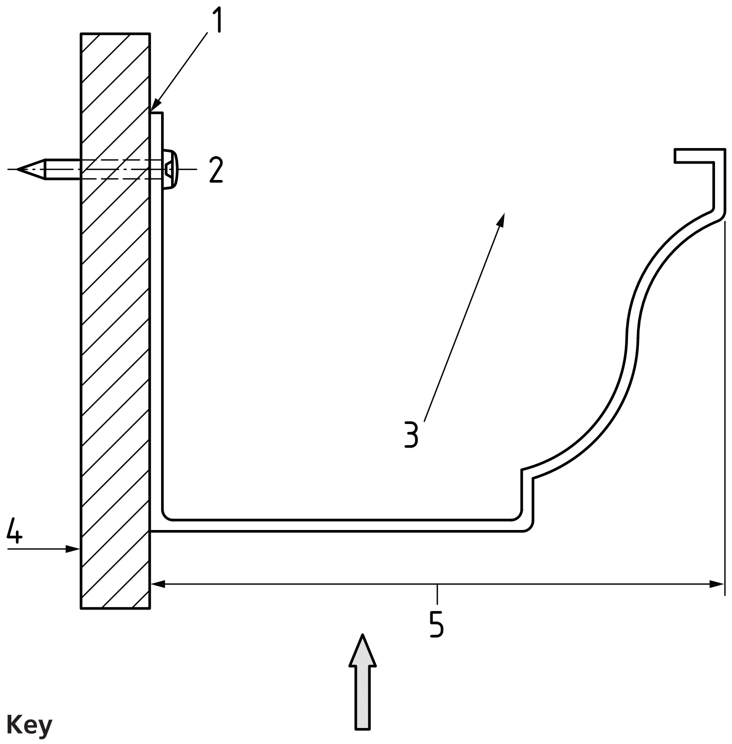
A.1.5.2 All holes in brackets, gutters and backgrounds shall be the same diameter specified and at the specified centres.

A.1.5.3 When creating the assembly for FEA, constrain all parts as they would be fixed in a real situation, or in accordance with the manufacturer's fitting instructions/specifications.

A.1.5.4 Place a form of background into the assembly to replicate a fascia board or wall, add the gutter, bracket and fixings, then place a constraint between the fixing holes in the gutter and the holes in each bracket.

A.1.5.5 The fixings through the gutter into the fascia/background shall be the main holding point in the structure, so all constraints can be set from these.

Figure A.10 **Test set-up for wind load test on Benchmark Test 2**



No connection

Calculations:
Gutter length = 0.925 m
Service = 1.74 kN per L/m
150 mm × 1.74 kN = 0.261 kN per L/m
0.261 kN × 0.925 m = 0.241 kN applied
Safety = 2.61 kN per/Lm
150 mm × 2.61 kN = 0.391 kN per L/m
0.391 kN × 0.925 m = 0.361 kN applied

Key

1 No connection between fascia and bracket
2 Fixing point
3 No brackets
4 Fixed
5 150 mm overall width (extrusion below 160 mm)

A.1.5.6 Constrain the fixings to the hole centres into the fascia/background, the fixing point, and offset the distance between the screw face and the background by adding the gutter thickness (2 mm) and the bracket thickness (5 mm): total offset 7 mm.

A.1.5.7 Constrain the face of each bracket to the mating fixing/screw face and then constrain the back of the gutter to the fascia/background face.

NOTE This becomes a separation constraint in the FEA test.

A.1.5.8 Send the assembly for stress analysis.

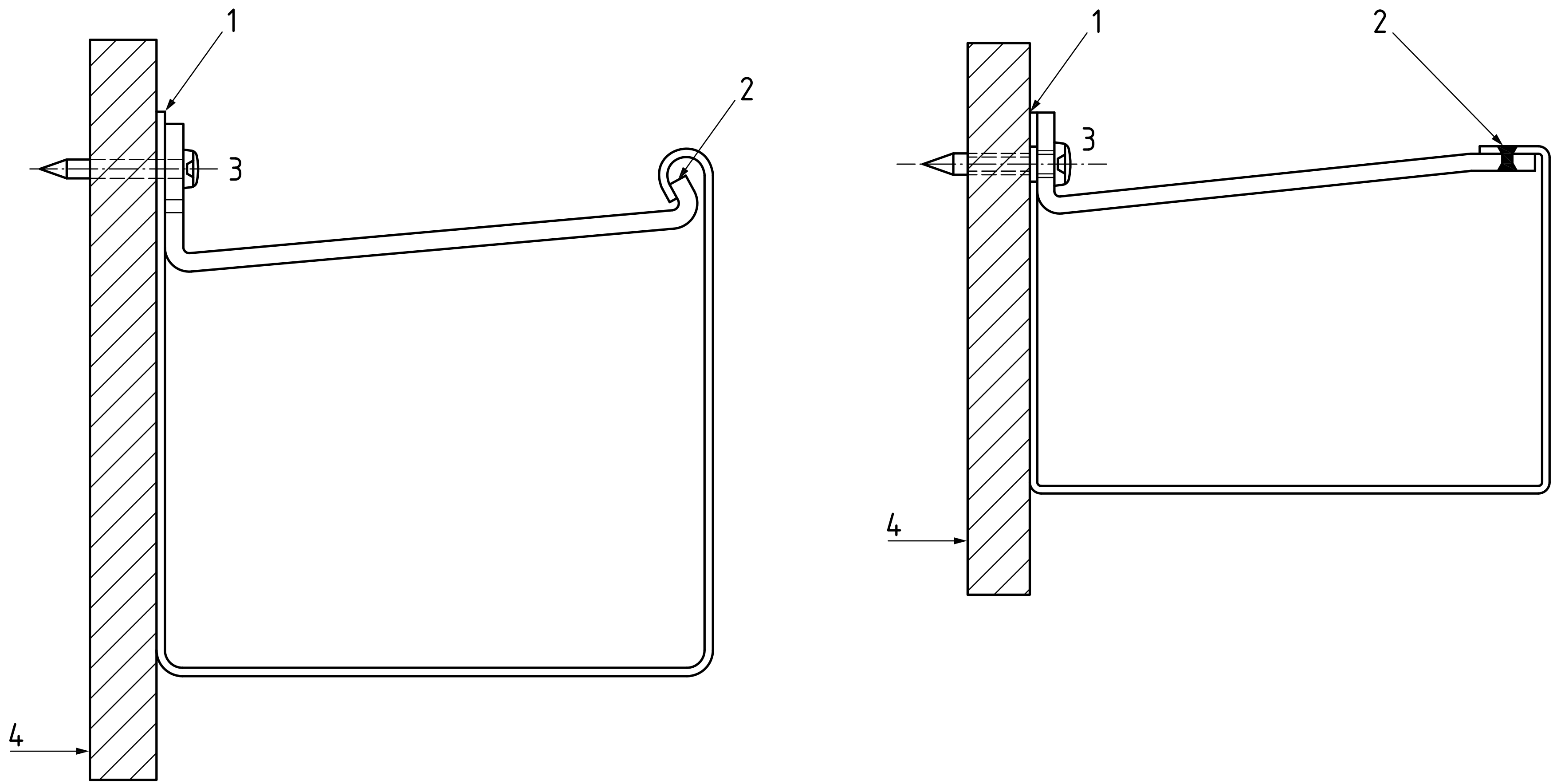
A.1.5.9 Assign materials: check the list to ensure the model has analysed the correct material grades for every part (see Table A.1).

A.1.5.10 Assign a fixed constraint to the back of the fascia/background.

A.1.5.11 Examine all contact constraints to establish that all of the connections in the assembly have been associated. Depending on the type of connections between backgrounds, gutter, fixings and support brackets, change the type of contact, i.e. if a bracket is welded this is a bonded type or if it is fixed by "hooking" or by a slot in the gutter then there is no immediate contact here and this would be a type of separation contact.

NOTE Examples of connections between brackets and gutters are given in Figure A.11 and Figure 12.

Figure A.11 **Examples of connections between brackets and gutters** *(1 of 2)*



a) No connection

Key

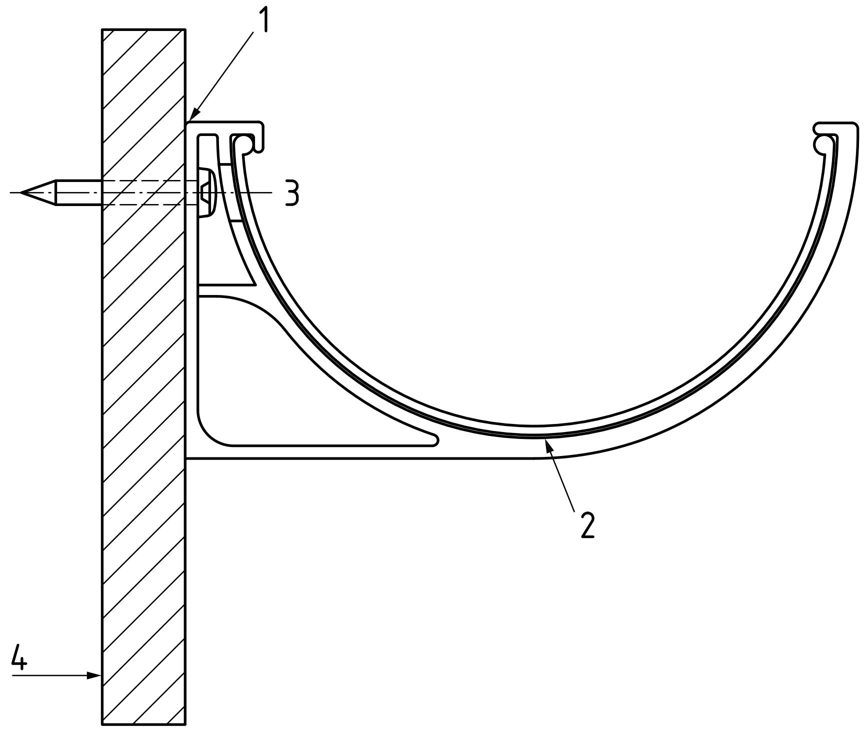
1	No connection between fascia and gutter
2	No connection between gutter and bracket
3	Fixing point
4	Fixed

b) Structural connection

Key

1	No connection between fascia and gutter
2	Gutter and bracket mechanically connected by rivet
3	Fixing point
4	Fixed

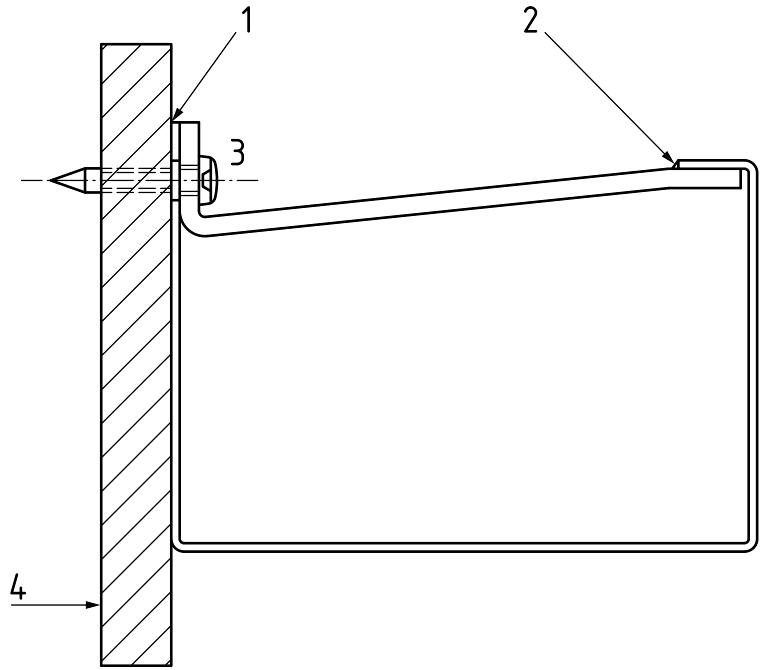
Figure A.11 **Examples of connections between brackets and gutters** *(2 of 2)*



c) No connection

Key

1	No connection between gutter and bracket
2	No connection between gutter and bracket
3	Fixing point
4	Fixed

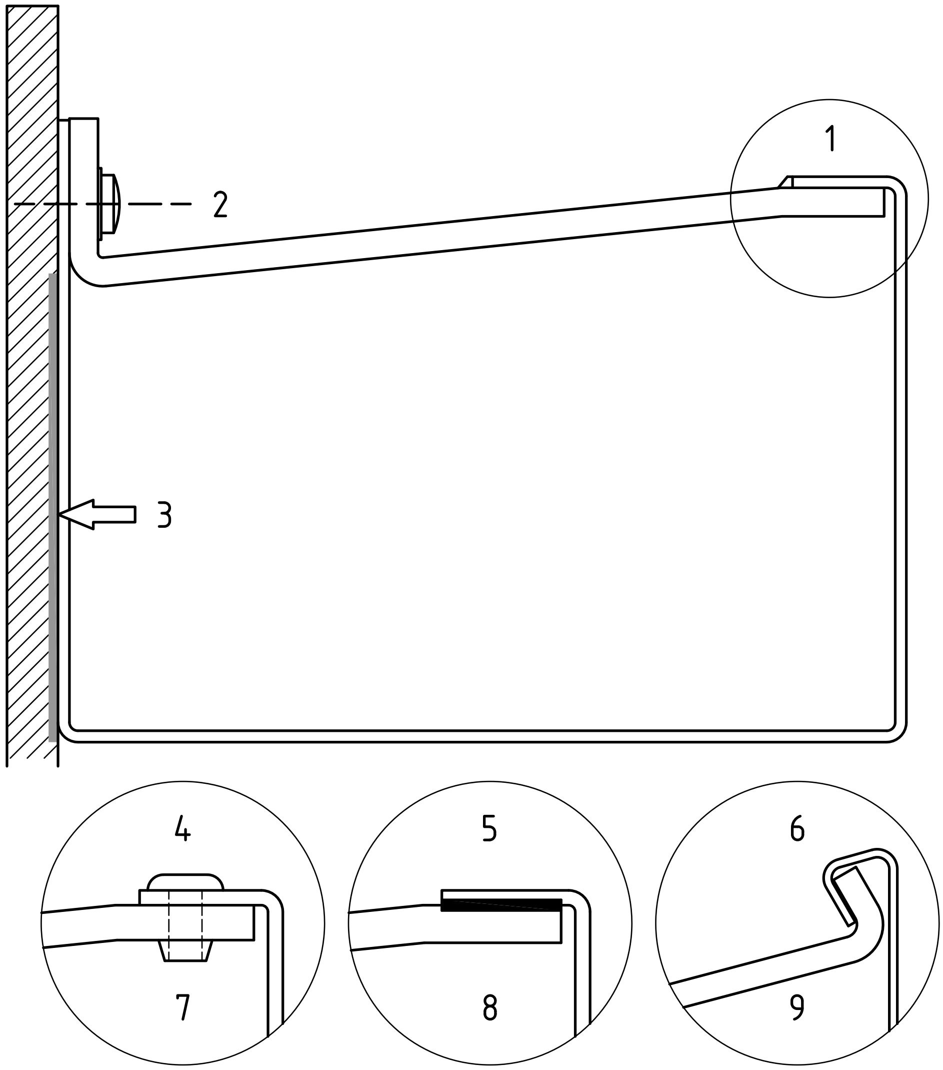


d) Bonded connection

Key

1	No connection between gutter and bracket
2	Gutter and bracket connected by weld
3	Fixing point
4	Fixed

Figure A.12 **Connection/Joint type as configured in FEA**



Key

1	Welded joint	6	Hook/slot loosely fixed
2	Fixed point	7	Mechanical joint
3	Separation joint	8	Bonded joint
4	Rivet/fixing	9	Separation joint
5	Adhesive		

A.2 Test sequences

A.2.1 Inboard gutter

The sequence of tests for each sample internal gutter (see Table A.4) shall be as follows:

- **water load** (see **A.3**): service load + safety load + deflection; and
- **pedestrian load** (see **A.4**): service load + safety load + deflection.

NOTE Snow loads for internal gutters are less than maximum water load and therefore do not require further testing.

A.2.2 Outboard gutter

The sequence of tests for each sample outboard gutter (see Table A.4) shall be as follows:

- **water load** (see **A.5**)**:** service load + safety load + deflection;
- **snow load** (see **A.7**)**:** service load + safety load + deflection; and

  NOTE Snow load assumed to be 4 kN/m³ obtained from BS EN 1991-1-3:2003+A1:2015, Annex E, over 100 mm thickness with a factor of 1.75 to allow for dynamic loading, in accordance with ISO 4355:2013, Annex E

- **wind load (uplift)** (see **A.6**)**:** service load + safety load.

A.3 Deflection under water load (inboard gutter supported on both sides)

A.3.1 Principle

This test simulates the effect of an internal gutter (valley or parapet), which is supported on both sides from secondary building steelwork, being full of water to its design depth

This test is an alternative to the use of physical testing described in Annex B.

A.3.2 Test method

A.3.2.1 Produce a CAD model of the gutter which includes an accurate representation of all components, including accurate bend and fold radii, and modify it to generate a 3D solid of length 3 m.

A.3.2.2 Export the model to a finite element stress analysis tool.

A.3.2.3 Ensure that all physical properties of all materials used in the model match the prototype product.

A.3.2.4 Select the gutter parts which on the prototype would be attached to the support structure of the building, and assign these as fixed surfaces.

A.3.2.5 Apply a vertical UDL (uniformly distributed load) to the inside face of the gutter, replicating the water service load, in accordance with Table A.4.

A.3.2.6 Run the finite element simulation on the gutter model.

A.3.2.7 Check that the maximum deflection and maximum recorded stress levels in the simulation do not exceed those stated for the service load case in Table A.4.

A.3.2.8 Apply a vertical UDL to the inside face of the gutter, replicating the water safety load, in accordance with Table A.4.

A.3.2.9 Run the finite element simulation on the gutter model.

A.3.2.10 Check that the maximum recorded stress levels in the simulation do not exceed those stated for the safety load case in Table A.4.

Table A.4 **Loads and deflection limits for gutter stress tests**

Case	Applied load	Reported stress	Reported deflection mm
Inboard gutter:			
Water load service loading case	Max. water depth in mm [A)] (kg/m^2)	<yield strength	Gutter sole width/50
Water load safety loading case	Max. water depth in mm [B)] × 1.5 (kg/m^2)	<max. tensile strength	N/A
Pedestrian load service loading case	1.2 kN point load	<yield strength	Gutter sole width/50
Pedestrian load safety loading case	1.8 kN point load	<max. tensile strength	N/A
Snow load service/safety loading case	See Note to **A.2.1**	–	N/A
Outboard extruded aluminium gutter (up to 160 mm overall width):			
Water load service loading case	Max. water depth in mm [A)] (kg/m^2)	N/A	Overall width/30
Water load safety loading case	Max. water depth in mm [C)] × 1.5 (kg/m^2)	N/A	Overall width/20
Snow load service loading case	0.7 kN per linear metre (UDL)	N/A	Overall width/11
Snow load safety loading case	1.05 kN per linear metre (UDL)	N/A	Overall width/7.5
Wind load service loading case	1.74 kN sq.m of the gutter underside (UDL)	N/A	Overall width/30
Wind load safety loading case	2.61 kN sq.m of the gutter underside (UDL)	N/A	Overall width/20
Outboard gutter (excluding extruded gutters up to 160 mm):			
Water load service loading case	Max. water depth in mm [A)] (kg/m^2)	N/A	Overall width/30
Water load safety loading case	Max. water depth in mm [C)] × 1.5 (kg/m^2)	N/A	Overall width/20
Snow load service loading case	0.7 kN per linear metre (UDL)	N/A	Overall width/30
Snow load safety loading case	1.05 kN per linear metre (UDL)	N/A	Overall width/20
Wind load service loading case	1.74 kN sq.m of the gutter underside (UDL)	N/A	Overall width/30
Wind load safety loading case	2.61 kN sq.m of the gutter underside (UDL)	N/A	Overall width/20

[A)] Maximum water is the design water depth in the gutter as defined by BS EN 12056-3:2000, **5.2.2**.

[B)] Maximum water is the depth of the gutter as defined by BS EN 12056-3:2000, **5.1.2**.

[C)] Maximum water is the depth of the overflows in external gutters not designed to run full.

UDL = Uniformly distributed load.

A.4 Deflection under pedestrian load (inboard gutter supported on both sides)

A.4.1 Principle

This test simulates the effect of an operative with tools walking in the gutter sole of an internal gutter (valley or parapet), which is supported on both sides from secondary building steelwork, imposing all their weight on a single contact point.

This test is an alternative to the use of physical testing described in Annex B.

A.4.2 Test method

A.4.2.1 Produce a CAD model of the gutter which includes an accurate representation of all components, including accurate bend and fold radii, and generate a 3D solid of length 3 m.

A.4.2.2 Export the model to a finite element stress analysis tool.

A.4.2.3 Ensure that all physical properties of all materials used in the model match the prototype product.

A.4.2.4 Select the gutter parts which on the prototype would be attached to the support structure of the building, and assign these as fixed surfaces.

A.4.2.5 Apply a vertical point load over an area measuring (125 × 125) mm at the centre point of the gutter in accordance with the service loading case in Table A.4.

A.4.2.6 Run the finite element simulation on the gutter model.

A.4.2.7 Check that the maximum deflection and maximum recorded stress levels in the simulation do not exceed those stated for the service load case in Table A.4.

A.4.2.8 Apply a vertical point load over an area measuring (125 × 125) mm at the centre point of the gutter in accordance with the safety loading case in Table A.4.

A.4.2.9 Run the finite element simulation on the gutter model.

A.4.2.10 Check that the maximum recorded stress levels in the simulation do not exceed those stated for the safety load case in Table A.4.

A.5 Deflection under water load (outboard gutter supported on one side)

A.5.1 Principle

This test simulates the effect of an external gutter (eaves), which is supported on one side from a building fascia, being full of water to its design depth.

This test is an alternative to the use of physical testing described in Annex B.

A.5.2 Test method

A.5.2.1 Produce a CAD model of the gutter assembly which includes an accurate representation of all components, including accurate bend and fold radii. The model shall be a 3D solid length with 2 × the manufacturer's recommended bracket spacings + the width of the bracket, e.g. for a gutter with 450 mm bracket spacing and 25 mm wide brackets, the test sample length is 925 mm; for a gutter with no brackets, the size is 2 × the manufacturer's recommended back fixing spacings + 25 mm.

A.5.2.2 Export the model to a finite element stress analysis tool where all materials for all components have accurate physical properties set and all joints and connections are configured to accurately reflect their physical type, i.e. bonded, sliding, separation, fixed. The connections shall accurately model the connection type, i.e. welded, hook-in, riveted, bolted, etc. (see Figure A.12). Any constraint to the building structure shall only be at recognized fixing points according to the manufacturer’s installation instructions. For the purpose of this test these constraints are considered fixed and absolute; fixity shall only be over the area which is actually fixed in the prototype structure. All other parts of the gutter in contact with the structure shall be free to move.

A.5.2.3 Apply a vertical UDL to the inside face of the gutter, replicating the water service load, in accordance with Table A.4.

A.5.2.4 Run the finite element simulation on the gutter model.

A.5.2.5 Check that the maximum deflection in the simulation does not exceed that stated for the service load case in Table A.4.

A.5.2.6 Apply a vertical UDL to the inside face of the gutter, replicating the water safety load, in accordance with Table A.4.

A.5.2.7 Run the finite element simulation on the gutter model.

A.5.2.8 Check that the maximum deflection in the simulation does not exceed that stated for the safety load case in Table A.4.

A.6 Deflection under wind load (outboard gutter supported on one side)

A.6.1 Principle

This test simulates the effect of an external gutter (eaves), which is supported on one side from a building fascia, being subjected to an uplift wind pressure.

This test is an alternative to the use of physical testing described in Annex B.

A.6.2 Test method

A.6.2.1 Produce a CAD model of the gutter which includes an accurate representation of all components, including accurate bend and fold radii. The model shall be a 3D solid length with 2 × the manufacturer’s recommended bracket spacings + the width of the bracket, e.g. for a gutter with 450 mm bracket spacing and 25 mm wide brackets, the test sample length is 925 mm; for a gutter with no brackets, the size shall be 2 × the manufacturer’s recommended back fixing spacings + 25 mm.

A.6.2.2 Export the model to a finite element stress analysis tool where all materials for all components have accurate physical properties set and all joints and connections are configured to accurately reflect their physical type, i.e. bonded, sliding, separation, fixed. The connections shall accurately model the connection type, i.e. welded, hook-in, riveted, bolted, etc. (see Figure A.12). Any constraint to the building structure shall only be at recognized fixing points according to the manufacturer’s installation instructions. For the purpose of this test these constraints are considered fixed and absolute. Fixity shall only be over the area which is actually fixed in the prototype structure; all other parts of the gutter in contact with the structure shall be free to move.

A.6.2.3 Apply an upwards vertical UDL to the outside base of the gutter, replicating the wind uplift service load, in accordance with Table A.4.

A.6.2.4 Run the finite element simulation on the gutter model.

A.6.2.5 Check that the maximum deflection in the simulation does not exceed that stated for the service load case in Table A.4.

A.7 Deflection under snow load (outboard gutter supported on one side)

A.7.1 Principle

This test simulates the effect of an external gutter (eaves), which is supported on one side from a building fascia, being subjected to a snow loading applied such as to replicate sliding snow. It might not fully represent the effect of velocity impact force and thus, for sensitive locations, additional calculations are necessary to assess the dynamic forces on the gutter. This test method is not applicable to systems using rise-and-fall gutters; alternative methods of protection are necessary for such systems.

This test is an alternative to the use of physical testing described in Annex B.

A.7.2 Test method

A.7.2.1 Produce a CAD model of the gutter which includes an accurate representation of all components, including accurate bend and fold radii. The model shall be a 3D solid length with 2 × the manufacturer's recommended bracket spacings + the width of the bracket, e.g. for a gutter with 450 mm bracket spacing and 25 mm wide brackets, the test sample length is 925 mm; for a gutter with no brackets, the size is 2 × the manufacturer's recommended back fixing spacings + 25 mm.

A.7.2.2 Export the model to a finite element stress analysis tool where all materials for all components have accurate physical properties set and all joints and connections are configured to accurately reflect their physical type, i.e. bonded, sliding, separation, fixed. The connections shall accurately model the connection type, i.e. welded, hook-in, riveted, bolted, etc. (see Figure A.12). Any constraint to the building structure shall only be at recognized fixing points according to the manufacturer's installation instructions. For the purpose of this test these constraints are considered fixed and absolute. Fixity shall only be over the area which is actually fixed in the prototype structure; all other parts of the gutter in contact with the structure shall be free to move.

A.7.2.3 Apply a UDL at an angle of 30° to the horizontal, in a downwards direction to the outside top lip of the gutter, replicating the snow service load, in accordance with Table A.4.

A.7.2.4 Run the finite element simulation on the gutter model.

A.7.2.5 Check that the maximum deflection in the simulation does not exceed that stated for the service load case in Table A.4.

A.7.2.6 Apply a UDL at an angle of 30° to the horizontal, in a downwards direction to the outside top lip of the gutter, replicating the snow safety load, in accordance with Table A.4.

A.7.2.7 Run the finite element simulation on the gutter model.

A.7.2.8 Check that the maximum deflection in the simulation does not exceed that stated for the safety load case in Table A.4.

Annex B (normative) Gutter stress test: Physical testing

COMMENTARY ON ANNEX B

The tests in this annex are an alternative to the use of finite element analysis in Annex A.

B.1 Test sequences

B.1.1 Inboard gutter

The sequence of tests for each sample internal gutter (see Table B.1) shall be as follows:

- **water load** (see **B.2**): service load + safety load; and
- **pedestrian load** (see **B.3**): service load + safety load.

NOTE Snow loads for internal gutters are less than maximum water load and therefore do not require further testing.

B.1.2 Outboard gutter

The sequence of tests for each sample outboard gutter (see Table B.1) shall be as follows:

- **water load** (see **B.4**): service load + safety load;
- **snow load** (see **B.6**): service load + safety load; and

  NOTE Snow load assumed to be 4 kN/m^3 obtained from BS EN 1991-1-3:2003+A1:2015, Annex E, over 100 mm thickness with a factor of 1.75 to allow for dynamic loading, in accordance with ISO 4355:2013, Annex E.

- **wind uplift** (see **B.5**): service load + safety load.

Table B.1 **Loads and deflection limits for gutter stress tests**

Case	Applied load	Reported stress	Reported deflection mm
Inboard gutter:			
Water load service loading case	Max. water depth in mm [A)] (kg/m²)	<yield strength	Gutter sole width/50
Water load safety loading case	Max. water depth in mm [B)] × 1.5 (kg/m²)	<max. tensile strength	N/A
Pedestrian load service loading case	1.2 kN point load	<yield strength	Gutter sole width/50
Pedestrian load safety loading case	1.8 kN point load	<max. tensile strength	N/A
Snow load service/safety loading case	See Note to **B.1.1**	–	N/A
Outboard extruded aluminium gutter (up to 160 mm overall width):			
Water load service loading case	Max. water depth in mm [A)] (kg/m²)	N/A	Overall width/30
Water load safety loading case	Max. water depth in mm [C)] × 1.5 (kg/m²)	N/A	Overall width/20
Snow load service loading case	0.7 kN per linear metre (UDL)	N/A	Overall width/11
Snow load safety loading case	1.05 kN per linear metre (UDL)	N/A	Overall width/7.5
Wind load service loading case	1.74 kN sq.m of the gutter underside (UDL)	N/A	Overall width/30
Wind load safety loading case	2.61 kN sq.m of the gutter underside (UDL)	N/A	Overall width/20
Outboard gutter (excluding extruded gutters up to 160 mm):			
Water load service loading case	Max. water depth in mm [A)] (kg/m²)	N/A	Overall width/30
Water load safety loading case	Max. water depth in mm [C)] × 1.5 (kg/m²)	N/A	Overall width/20
Snow load service loading case	0.7 kN per linear metre (UDL)	N/A	Overall width/30
Snow load safety loading case	1.05 kN per linear metre (UDL)	N/A	Overall width/20
Wind load service loading case	1.74 kN per sq.m of the gutter underside (UDL)	N/A	Overall width/30
Wind load safety loading case	2.61 kN per sq.m of the gutter underside (UDL)	N/A	Overall width/20

[A)] Maximum water is the design water depth in the gutter as defined by BS EN 12056-3:2000, **5.2.2**.

[B)] Maximum water is the depth of the gutter as defined by BS EN 12056-3:2000, **5.1.2**.

[C)] Maximum water is the depth of the overflows in external gutters not designed to run full.

UDL = Uniformly distributed load.

B.2 Deflection under water load (inboard gutter supported on both sides)

B.2.1 Principle

This test simulates the effect of an internal gutter (valley or parapet), which is supported on both sides from secondary building steelwork, being full of water to its design depth.

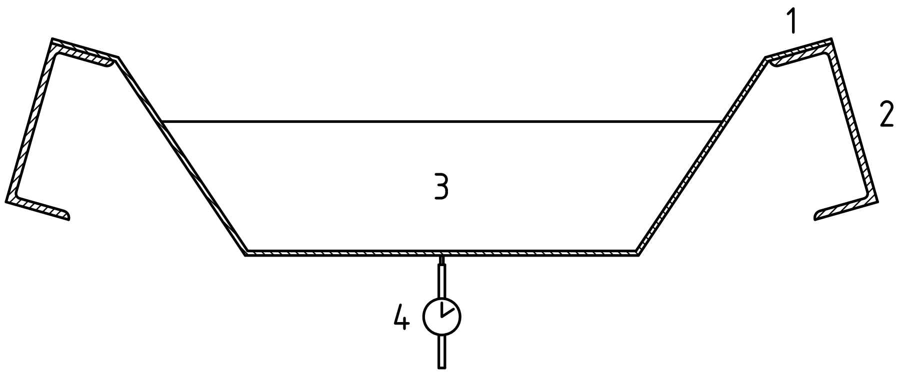
B.2.2 Test method

B.2.2.1 Install a 3 m length of gutter, securely fixed to two support rails, level to ±2 mm, using fixings at the manufacturer's recommended fixing spacing (see Figure B.1).

B.2.2.2 Install a calibrated dial gauge as close to the mid-point of the gutter as possible and midway between any brackets to measure the deflection that occurs during the test (see Figure B.1).

B.2.2.3 Spread an even layer of sand of a known density in the gutter at a thickness sufficient to generate the service loading UDL (uniformly distributed load) given in Table B.1.

Figure B.1 **Test equipment for simulated water load test**



Key

1 Test gutter rigidly fixed to support rail
2 Rigid support rail
3 Uniformly distributed load applied by measured thickness of sand of known density
4 Dial gauge as close as possible to gutter mid-point, midway between any brackets

B.2.2.4 Read the value of the dial gauge and subtract the zero value to calculate the deflection under applied service loading water load.

B.2.2.5 After 5 min re-read the dial gauge to check for any long-term creep. If the value is the same as the value recorded as soon as the load was applied ±0.5 mm, then the gutter sample can be unloaded. If the gutter has continued to deflect, record the new reading and take another reading every 5 min until either the gutter stops deflecting or the service loading deflection limit in Table B.1 is exceeded.

B.2.2.6 Remove the load from the gutter, and take a final dial gauge measurement. Record this measurement as the service loading permanent deflection value, after subtracting the zero measurement.

B.2.2.7 Spread an even layer of sand of a known density in the gutter at a thickness sufficient to generate the safety loading UDL given in Table B.1.

B.2.2.8 Read the value of the dial gauge and subtract the zero value to calculate the deflection under applied safety loading water load.

B.2.2.9 After 5 min re-read the dial gauge to check for any long-term creep. If the value is the same as the value recorded as soon as the load was applied ±0.5 mm, then the gutter sample can be unloaded. If the gutter has continued to deflect, record the new reading and take another reading every 5 min until either the gutter stops deflecting or the safety loading deflection limit in Table B.1 is exceeded.

B.2.2.10 Remove the load from the gutter, and take a final dial gauge measurement. Record this measurement as the safety loading permanent deflection value, after subtracting the zero measurement.

B.3 Deflection under pedestrian load (inboard gutter supported on both sides)

B.3.1 Principle

This test simulates the effect of an operative with tools walking in the gutter sole of an internal gutter (valley or parapet), which is supported on both sides from secondary building steelwork, imposing all their weight on a single contact point.

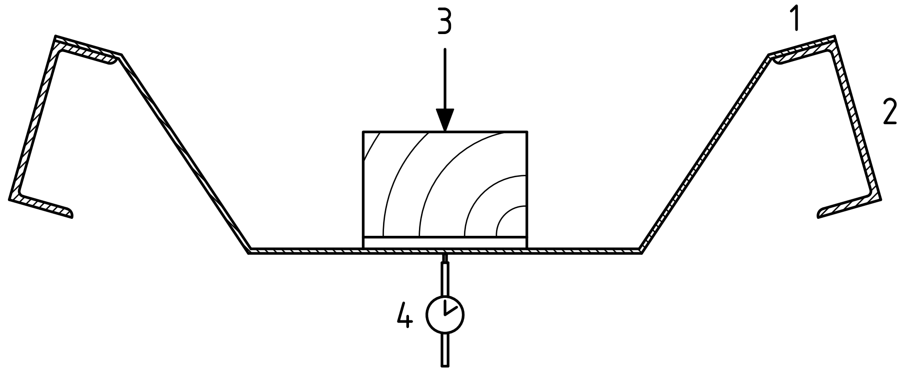
This test is an alternative to the use of finite element analysis described in Annex A.

B.3.2 Test method

B.3.2.1 Install a 3 m length of gutter, securely fixed to two support rails, level to ±2 mm, using fixings at the manufacturer’s recommended fixing spacing (see Figure B.2).

B.3.2.2 Install a calibrated dial gauge as close to the mid-point of the gutter as possible and midway between any brackets to measure the deflection that occurs during the test. Take a zero reading before the test begins (see Figure B.2).

Figure B.2 **Test equipment for pedestrian load test**



Key

1 Test gutter rigidly fixed to support rail

2 Rigid support rail

3 Test load applied via a (125 × 125) mm test platen, 80 mm thick, separated from gutter by rubber pad

4 Dial gauge as close as possible to gutter mid-point, midway between any brackets

B.3.2.3 Apply a vertical force as defined in Table B.1 to the centre point of the gutter sample via a rigid square platen of (125 × 125) mm, with a minimum thickness of 80 mm. In order to avoid local stress, a 10 mm to 15 mm thick layer of rubber of shore hardness A 20-30 determined according to BS EN ISO 868 can be placed between the test platen and the gutter under test.

B.3.2.4 Read the value of the dial gauge and subtract the zero value to calculate the deflection under the service loading pedestrian load.

B.3.2.5 After 5 min re-read the dial gauge to check for any long-term creep. If the value is the same as the value recorded as soon as the load was applied ±0.5 mm, then the gutter sample can be unloaded. If the gutter has continued to deflect, record the new reading and take another reading every 5 min until either the gutter stops deflecting or the service loading deflection limit is exceeded.

B.3.2.6 Remove the load and take a final dial gauge reading. Record this measurement as the service loading permanent deflection value, after subtracting the zero measurement.

B.3.2.7 Apply a vertical force as defined in Table B.1 to the centre point of the gutter sample via a rigid square platen of (125 × 125) mm, with a minimum thickness of 80 mm. In order to avoid local stress, a 10 mm to 15 mm thick layer of rubber of shore hardness A 20-30 determined according to BS EN ISO 868 can be placed between the test platen and the gutter under test.

B.3.2.8 Read the value of the dial gauge and subtract the zero value to calculate the deflection under the safety loading pedestrian load.

B.3.2.9 After 5 min re-read the dial gauge to check for any long-term creep. If the value is the same as the value recorded as soon as the load was applied ±0.5 mm, then the gutter sample can be unloaded. If the gutter has continued to deflect, record the new reading and take another reading every 5 min until either the gutter stops deflecting or the service loading deflection limit is exceeded.

B.3.2.10 Remove the load and take a final dial gauge reading. Record this measurement as the permanent safety loading deflection value, after subtracting the zero measurement.

B.4 Deflection under water load (outboard gutter supported on one side)

B.4.1 Principle

This test simulates the effect of an external gutter (eaves), which is supported on one side from a building fascia, being full of water to its design depth.

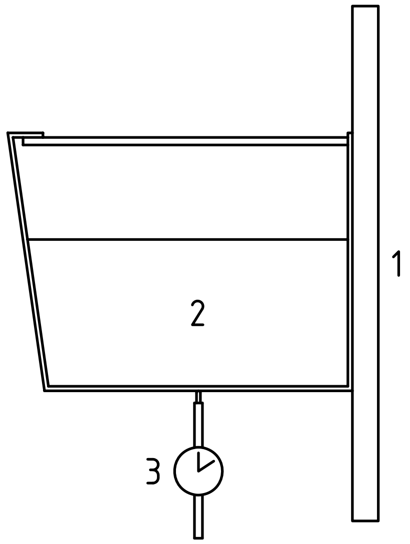
This test is an alternative to the use of finite element analysis described in Annex A.

B.4.2 Test method

B.4.2.1 Install a minimum length of gutter = 2 × the manufacturer's recommended bracket spacings + the width of the bracket, e.g. for a gutter with 450 mm bracket spacing and 25 mm wide brackets, the test sample length is 925 mm; for gutters with no brackets, the size is 2 × the manufacturer's recommended back fixing spacings + 25 mm (see Figure B.3).

B.4.2.2 Securely fix the gutter to a solid fascia board using the manufacturer's recommended bracketry system, fixed using the manufacturer's recommended fixings at the manufacturer's recommended bracket and fixing centres, level to ±2 mm (see Figure B.3).

Figure B.3 **Test equipment for simulated water load test**



Key

1 Test gutter rigidly fixed to simulated fascia board

2 Uniformly distributed load applied by measured thickness of sand of known density

3 Dial gauge as close as possible to gutter mid-point, midway between any brackets

B.4.2.3 Install a calibrated dial gauge midway between any brackets to measure the deflection that occurs during the test. Take a zero reading before the test begins.

B.4.2.4 Spread an even layer of sand of a known density in the gutter at a thickness sufficient to generate the service loading UDL given in Table B.1. Remove the load from the gutter and record the dial gauge reading. Take this as the zero reading, allowing for initial settlement on fixings.

B.4.2.5 Spread an even layer of sand of a known density in the gutter at a thickness sufficient to generate the service loading UDL given in Table B.1.

B.4.2.6 Read the value of the dial gauge and subtract the zero value to calculate the deflection under service loading water load.

B.4.2.7 After 5 min re-read the dial gauge to check for any long-term creep. If the value is the same as the value recorded as soon as the load was applied ±0.5mm, then the gutter sample can be unloaded. If the gutter has continued to deflect, record the reading and take another reading every 5 min until either the gutter stops deflecting or the service loading deflection limit is exceeded.

B.4.2.8 Remove the load from the gutter, and take a final dial gauge measurement. Record this measurement as the service loading permanent deflection value, after subtracting the zero measurement.

B.4.2.9 Spread an even layer of sand of a known density in the gutter at a thickness sufficient to generate the safety loading UDL stated in Table B.1.

B.4.2.10 Read the value of the dial gauge and subtract the zero value to calculate the deflection under safety loading water load.

B.4.2.11 After 5 min re-read the dial gauge to check for any long-term creep. If the value is the same as the value recorded as soon as the load was applied ±0.5 mm, then the gutter sample can be unloaded. If the gutter has continued to deflect, record the reading and take another reading every 5 min until either the gutter stops deflecting or the safety loading deflection limit is exceeded.

B.4.2.12 Remove the load and take a final dial gauge measurement. Record this measurement as the safety loading permanent deflection value, after subtracting the zero measurement.

B.5 Deflection under wind load (outboard gutter supported on one side)

B.5.1 Principle

This test simulates the effect of an external gutter (eaves), which is supported on one side from a building fascia, being subjected to an uplift wind pressure.

This test is an alternative to the use of finite element analysis described in Annex A.

B.5.2 Test method

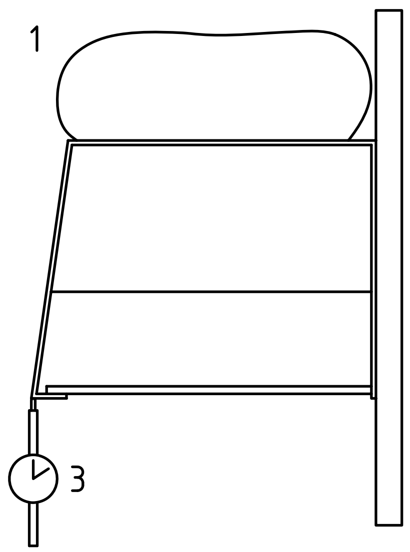
B.5.2.1 Install a minimum 1.8 m length of gutter = 2 × the manufacturer's recommended bracket spacings + the width of the bracket, e.g. for a gutter with 450 mm bracket spacing and 25 mm wide brackets, the test sample length is 925 mm; for gutters with no brackets, the size is 2 × the manufacturer's recommended back fixing spacings + 25 mm (see Figure B.4).

B.5.2.2 Securely fix the gutter to a solid fascia board using the manufacturer's recommended bracketry system, fixed using the manufacturer's recommended fixings at the manufacturer's recommended bracket and fixing centres, level to ±2 mm (see Figure B.4).

B.5.2.3 Install a calibrated dial gauge midway between any brackets to measure the deflection that occurs during the test (see Figure B.4). Take a zero reading before the test begins.

B.5.2.4 Apply a UDL to generate the service loading wind load given in Table B.1 to the bottom face of the gutter by means of sandbags of the correct mass (see Figure B.4).

Figure B.4 **Test equipment for wind uplift test**



Key

1 Simulation of wind uplift load applied using sandbags

2 Test gutter rigidly fixed to simulated fascia board

3 Dial gauge as close as possible to gutter mid-point, midway between any brackets

B.5.2.5 Read the value of the dial gauge and subtract the zero value to calculate the deflection under the service loading wind load.

B.5.2.6 After 5 min re-read the dial gauge to check for any long-term creep. If the value is the same as the value recorded as soon as the load was applied ±0.5 mm, then the gutter sample can be unloaded. If the gutter has continued to deflect, record the reading and take another reading every 5 min until either the gutter stops deflecting or the service loading deflection limit is exceeded.

B.5.2.7 Remove the applied load from the gutter sample, and take a final dial gauge measurement. Record this measurement as the service loading permanent deflection value, after subtracting the zero measurement.

B.5.2.8 Apply a UDL to generate the safety loading wind load as set out in Table B.1 to the bottom face of the gutter by means of sandbags of the correct mass (see Figure B.4).

B.5.2.9 Read the value of the dial gauge and subtract the zero value to calculate the deflection under the safety loading wind load.

B.5.2.10 After 5 min re-read the dial gauge for any long-term creep. If the value is the same as the value recorded as soon as the load was applied ±0.5 mm, then the gutter sample can be unloaded. If the gutter has continued to deflect, record the reading and take another reading every 5 min until either the gutter stops deflecting or the safety loading deflection limit is exceeded.

B.5.2.11 Remove the applied load from the gutter sample, and take a final dial gauge measurement. Record this measurement as the safety loading permanent deflection value, after subtracting the zero measurement.

B.6 Deflection under snow load (outboard gutter supported on one side)

B.6.1 Principle

This test simulates the effect of an external gutter (eaves), which is supported on one side from a building fascia, being subjected to a snow loading applied such as to replicate sliding snow. It might not fully represent the effect of velocity impact force and thus, for sensitive locations, additional calculations are necessary to assess the dynamic forces on the gutter. This test method is not applicable to systems using rise-and-fall gutters; alternative methods of protection are necessary.

This test is an alternative to the use of finite element analysis described in Annex A.

B.6.2 Test method

B.6.2.1 Install a minimum 1.8 m length of gutter = 2 × the manufacturer's recommended bracket spacings + the width of the bracket, e.g. for a gutter with 450 mm bracket spacing and 25 mm wide brackets, the test sample length is 925 mm; for gutters with no brackets, the size is 2 × the manufacturer's recommended back fixing spacings + 25 mm (see Figure B.5).

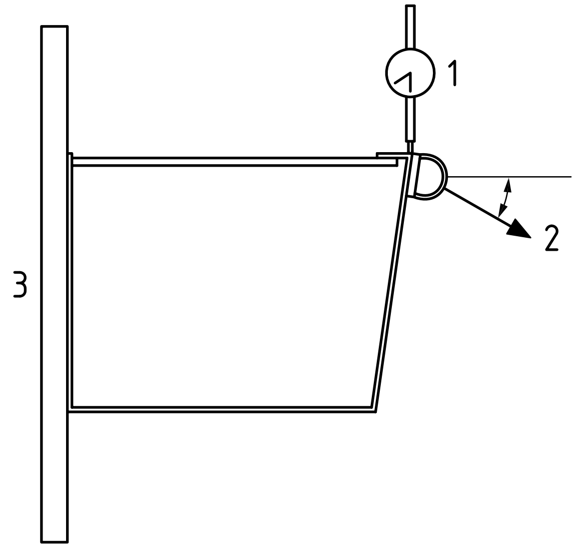
B.6.2.2 Securely fix the gutter to a solid fascia board using the manufacturer's recommended bracketry system and the manufacturer's recommended fixings at the manufacturer's recommended bracket and fixing centres, level to ±2 mm (see Figure B.5).

B.6.2.3 Install a calibrated dial gauge midway between any brackets to measure the deflection that occurs during the test (see Figure B.5). Take a zero reading before the test begins.

B.6.2.4 Apply a uniformly distributed load as defined in Table B.1 to the front edge of the gutter by means of a rigid loading bar (see Figure B.5).

NOTE This should be a (25 × 5) mm steel section with loading points welded on at 400 mm centres spaced evenly about the gutter centreline.

Figure B.5 **Test equipment for snow load test**



Key

1 Dial gauge as close as possible to gutter mid-point, midway between any brackets

2 Load applied at 30° to the horizontal

3 Test gutter rigidly fixed to simulated fascia board

B.6.2.5 Read the value of the dial gauge and subtract the zero value to calculate the deflection under water load.

B.6.2.6 After 5 min re-read the dial gauge to check for any long-term creep. If the value is the same as the value recorded as soon as the load was applied ±0.5mm, then the gutter sample can be unloaded. If the gutter has continued to deflect, record the reading and take another reading every 5 min until either the gutter stops deflecting or the deflection limit is exceeded.

B.6.2.7 Remove the applied load from the gutter sample, and take a final dial gauge measurement. Record this measurement as the permanent deflection value, after subtracting the zero measurement.

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For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

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