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Railway applications — Polymeric composite sleepers, bearers and transoms —

Part 2:
Product testing

Applications ferroviaires — Traverses et supports en matériaux composites à matrice polymère —

Partie 2: Essais de produit

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 269, *Railway applications*, Subcommittee SC 1, *Infrastructure*.

A list of all parts in the ISO 12856 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

This document is used as the technical basis for transactions between corresponding parties (purchaser – supplier).

Railway applications — Polymeric composite sleepers, bearers and transoms —

Part 2:
Product testing

1 Scope

This document specifies various test methods to ensure the performance of polymeric composite and reinforced polymeric composite sleepers, bearers and transoms for use in tracks. It is applicable to the sleepers, bearers and transoms to be installed in tracks with or without a ballast.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 7500-1, *Metallic materials — Calibration and verification of static uniaxial testing machines — Part 1: Tension/compression testing machines — Calibration and verification of the force-measuring system*

ISO 12856-3:—[1], *Railway applications — Polymeric composite sleepers, bearers and transoms — Part 3: General requirements*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 12856-3 apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

4 Symbols and abbreviated terms

For the purposes of this document, the symbols and abbreviated terms listed in Table 1 apply.

Table 1 — Symbols

Symbol/ Abbreviated term	Description	Unit
C_{dyn}	low frequency dynamic bedding modulus of polymeric composite sleeper or bearer measured with GBP	N/mm^3
C_{max}	static bedding modulus of polymeric composite sleeper or bearer measured with geometric ballast plate (GBP)	N/mm^3
$d_{fat,lim}$	acceptable displacement of fatigue test as a maintenance policy	mm
d_{0c}	deformation of the sleeper in the compression test under F_{r0}	mm

1) Under preparation. Stage at the time of publication: ISO/DIS 12856-3:2020.

Table 1 *(continued)*

Symbol/ Abbreviated term	Description	Unit
d_{1c}	deformation of the sleeper in the compression test under $k_{1s} \times F_{r0}$	mm
$d_{1s,lim}$	upper limit deformation related to the exceptional test load	mm
d_{2c}	deformation of the sleeper in the compression test under $k_{2s} \times F_{r0}$	mm
$d_{2s,lim}$	upper limit deformation related to the accidental test load	mm
Δk_c	variation of static and dynamic stiffness before and after the fatigue test at the centre section for positive bending moments	MN/m
$\Delta k_{c,n}$	variation of static and dynamic stiffness before and after the fatigue test at the centre section for negative bending moments	MN/m
Δk_r	the variation of static and dynamic stiffness before and after the fatigue test at the rail seat	MN/m
e	design distance between the centre line of the rail seat to the longitudinal girders of bridge	m
E_S	thickness of ballast bed in a ballast box	mm
F_c	positive test load at the centre section of the sleeper	kN
F_{c0}	positive initial test load at the centre section of the sleeper	kN
$F_{c,n}$	negative test load at the centre section of the sleeper	kN
$F_{c,fat}$	positive fatigue test load at the centre section of the sleeper	kN
$F_{c,fat,n}$	negative fatigue test load at the centre section of the sleeper	kN
$F_{c,perm,n}$	constant load applied for permanent deformation test at the centre section for negative bending moments	kN
FP	flat plate	n/a
F_r	positive test load for the rail seat section	kN
F_{rB}	maximum positive test load at the rail seat section which cannot be increased	kN
$F_{r,fat}$	positive fatigue test load for the rail seat section	kN
F_{r0}	positive initial reference test load for the rail seat section	kN
GBP	geometric ballast plate	n/a
$k_{c,dyn1}$	low frequency dynamic stiffness on 10 cycles under applying a cyclic force of $F_{c,min}$ (= 0,1 · F_{c0}) to $F_{c,test1}$ (= 0,5 · F_{c0}) at (5 ±1) Hz for 1 000 cycles	MN/m
$k_{c,dyn2}$	Low frequency dynamic stiffness on 10 cycles under applying a cyclic force of $F_{c,min}$ (= 0,1 · F_{c0}) to $F_{c,test2}$ (= F_{c0}) at (5 ±1) Hz for 1 000 cycles	MN/m
$k_{c,n,stat1}$	static stiffness of the fifth loading at the centre section for negative bending loads between (0.1· $F_{c0,n}$) and (0.5 · $F_{c0,n}$)	MN/m
$k_{c,n,stat2}$	static stiffness of the fifth loading at the centre section for negative bending loads between (0.1 · $F_{c0,n}$) and $F_{c0,n}$	MN/m
k_{dyn}	low frequency dynamic stiffness of polymeric composite sleeper or bearer measured with GBP	MN/m
k_{max}	static stiffness of polymeric composite sleeper or bearer measured with GBP	MN/m
$k_{r,dyn1}$	low frequency dynamic stiffness on 10 cycles under applying a cyclic force of $F_{r,min}$ (= 0,1 · F_{r0}) to $F_{r,test1}$ (= 0,5 · F_{r0}) at (5 ±1) Hz for 1 000 cycles	MN/m
$k_{r,dyn2}$	low frequency dynamic stiffness on 10 cycles under applying a cyclic force of $F_{r,min}$ (= 0,1 · F_{r0}) to $F_{r,test2}$ (= F_{r0}) at (5 ±1) Hz for 1 000 cycles	MN/m
k_{1s}	load factor of exceptional test load level	n/a
k_{2s}	load factor of accidental test load level	n/a
k_3	static coefficient to be used for calculation of F_{rB} at the end of fatigue test and provided by the purchaser	n/a
L_B	shoulder length of ballast bed in a ballast box	mm

Table 1 *(continued)*

Symbol/ Abbreviated term	Description	Unit
L_c	design distance between centre lines of the rail seat	m
L_O	length measured on the opposite side of top of sleeper, bearer or transom for Thermal expansion test	m
L_p	design distance between the centre line of the rail seat to the edge of the sleeper at the bottom	m
L_r	design distance between the articulated supports centre lines for the test arrangement at the rail seat section	m
L_s	length between the supports on the longitudinal girders of the bridge	m
L_T	length measured on the top of the sleeper, bearer or transom for Thermal expansion test	m
$M_{k,b}$	characteristic bending moment for transom	kN.m
$M_{k,c,neg}$	negative characteristic bending moment at centre station	kN.m
$M_{k,c,pos}$	positive characteristic bending moment at centre station	kN.m
$M_{k,r,pos}$	positive characteristic bending moment at rail seat	kN.m
Q_{nom}	nominal wheel load (static wheel load)	kN

5 Product characteristics

5.1 General

This clause defines the testing regime and rules for the acceptance of polymeric composite sleepers, bearers and transoms.

The bending tests are defined for ballasted track. For ballastless track, the test arrangement shall be reviewed in order to adapt to the real configuration of the track.

5.2 Bending resistance

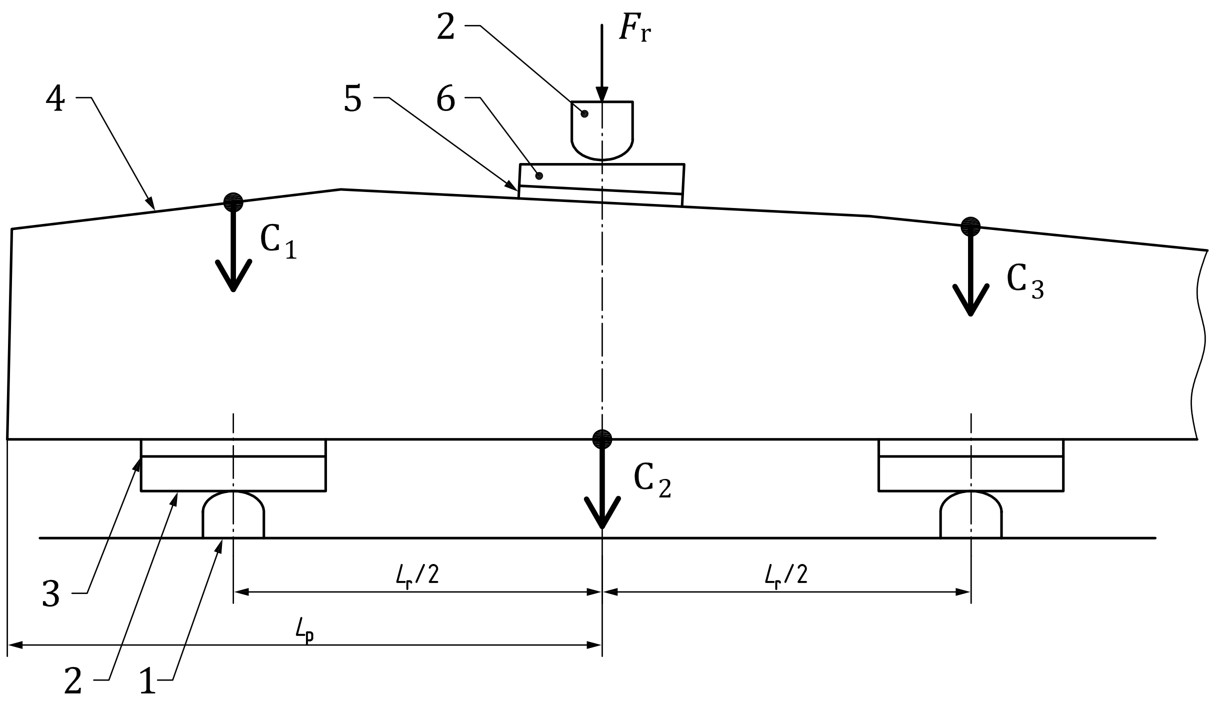
5.2.1 Test arrangements

5.2.1.1 Rail seat section for the positive load test for sleepers

The arrangement for the rail seat positive load test is shown in Figure 1; the value of L_r in relation to L_p is detailed in Table 2.

The load, F_r, is applied perpendicularly to the base of the sleeper.

The end of the sleeper opposite to the end being tested shall not be fixed.



Key

1	rigid support
2	articulated support and steel plate (minimum length: bottom width of the sleeper at the rail seat +20 mm, width: 140 ± 1 mm, thickness: minimum 12 mm and minimum hardness Brinell: HBW > 240)
3	resilient pad (minimum length: bottom width of the sleeper at the rail seat + 20 mm, width: 140 + $^{+10}_{0}$ mm, thickness: 15 $^{+2}_{-3}$ mm and static bedding modulus: static secant bedding modulus measured between 0,3 MPa and 2 MPa: 1 ≤ C ≤ 4 N/mm³)
4	polymeric composite sleeper without the fastening system and with baseplate (if used)
5	standard rail pad as defined by the purchaser
6	steel tapered packing compensating the inclination of the rail seat (minimum length: length of the standard rail pad +20 mm, width: 140 ± 1 mm (this width can be reduced in line with the real width of the rail foot used in track), thickness: minimum 12 mm and minimum hardness Brinell: HBW > 240)
C_1, C_2 and C_3	locations of the vertical displacement measurement on the axis of the articulated support
F_r	positive test load for the rail seat section
L_r	design distance between the articulated supports centre lines for the test arrangement at the rail seat section
L_p	design distance between the centre line of the rail seat to the edge of the sleeper at the bottom

Figure 1 — Test arrangement at the rail seat section for the positive load test

The deformation, d, measured during the tests on the rail seat is calculated with Formula (1):

$$d = C_2 - \frac{C_1 + C_3}{2} \quad (1)$$

Table 2 — Value of L_r in relation to L_p

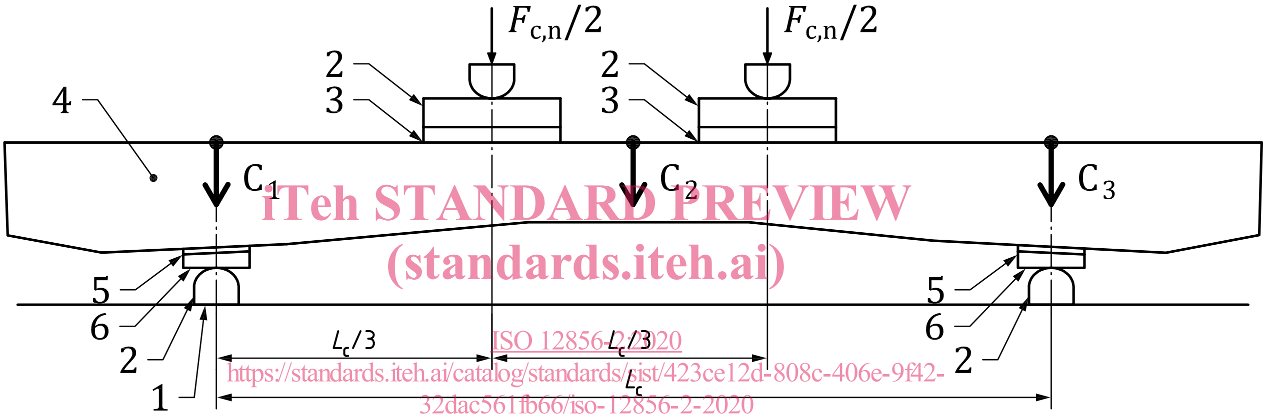
L_p m	L_r m
$L_p < 0{,}349$	0,3
$0{,}350 \le L_p < 0{,}399$	0,4
$0{,}400 \le L_p < 0{,}449$	0,5
$L_p \ge 0{,}450$	0,6

The displacement measuring instruments shall be capable of measuring the displacement within ±0,02 mm.

The force measuring instruments shall conform to ISO 7500-1, class 2, over the required range of force.

5.2.1.2 Centre section for the negative load test for sleepers

The arrangement for the negative centre load test is shown in Figure 2.



Key

1 rigid support

2 articulated support and steel plate (minimum length: bottom width of the sleeper at the rail seat +20 mm, width: 140 ± 1 mm, thickness: minimum 12 mm and minimum hardness Brinell: HBW > 240)

3 resilient pad (minimum length: bottom width of the sleeper at the rail seat + 20 mm, width: 140 $^{+10}_{0}$ mm, thickness: 15 $^{+2}_{-3}$ mm and static bedding modulus: static secant bedding modulus measured between 0,3 MPa and 2 MPa: $1 \le C \le 4$ N/mm^3)

4 polymeric composite sleeper with or without the fastening system and the baseplate (if used);

5 standard rail pad as defined by the purchaser

6 steel tapered packing compensated the inclination of the rail seat (minimum length: length of the standard
rail pad +20 mm, width: 140 ± 1 mm [this width can be reduced in line with the real width of the rail foot used in track], thickness: minimum 12 mm and minimum hardness Brinell: HBW > 240)

C_1, C_2 and C_3 locations of the vertical displacement measurement on the axis of the articulated support of the rail seats and the centre of the sleeper

$F_{c,n}$ negative reference test load at the centre section of the sleeper

L_c design distance between centre lines of the rail seat

Figure 2 — Test arrangement at the centre section for the negative load test

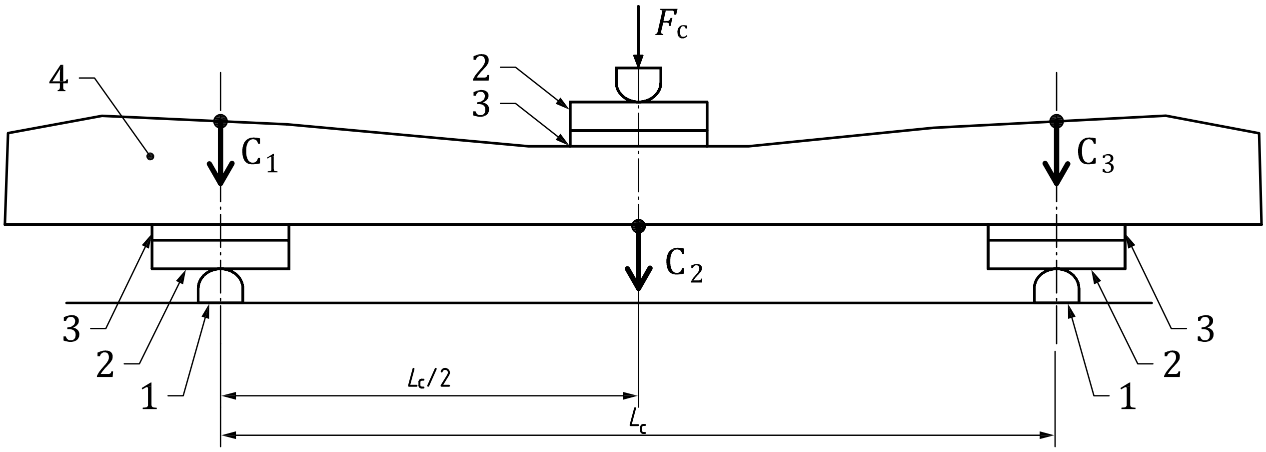
The deformation, *d*, measured during the tests on the centre section for the negative load is calculated using Formula (1).

The displacement measuring instruments shall be capable of measuring the displacement within ±0,02 mm.

The force measuring instruments shall conform to ISO 7500-1, class 2, over the required range of force.

5.2.1.3 Centre section for the positive load test for sleepers

The test arrangement for the positive centre load test is shown in Figure 3.



Key

1	rigid support
2	articulated support and steel plate (minimum length: bottom width of the sleeper at the rail seat +20 mm, width: 140 ± 1 mm, thickness: minimum 12 mm and minimum hardness Brinell: HBW > 240)
3	resilient pad (minimum length: bottom width of the sleeper at the rail seat + 20 mm, width: 140 $^{+10}_{0}$ mm, thickness: 15 + $^{+2}_{-3}$ mm and static bedding modulus: static secant bedding modulus measured between 0,3 MPa and 2 MPa: 1 ≤ C 4 N/mm^3)
4	polymeric composite sleeper with or without the fastening system and without the baseplate
C_1, C_2 and C_3	locations of the vertical displacement measurement on the axis of the articulated support
F_c	positive test load at the centre section of the sleeper
L_c	design distance between centre lines of the rail seat

Figure 3 — Test arrangement at the centre section for the positive load test

The deformation, *d*, measured during the tests on the centre section for the negative load is calculated using Formula (1).

The displacement measuring instruments shall be capable of measuring the displacement within ±0,02 mm.

The force measuring instruments shall conform to ISO 7500-1, class 2, over the required range of force.

5.2.1.4 Rail seat section for the positive load test for bearers

The arrangement for the rail seat positive load at a rail seat:

— next to the end of the bearer, and

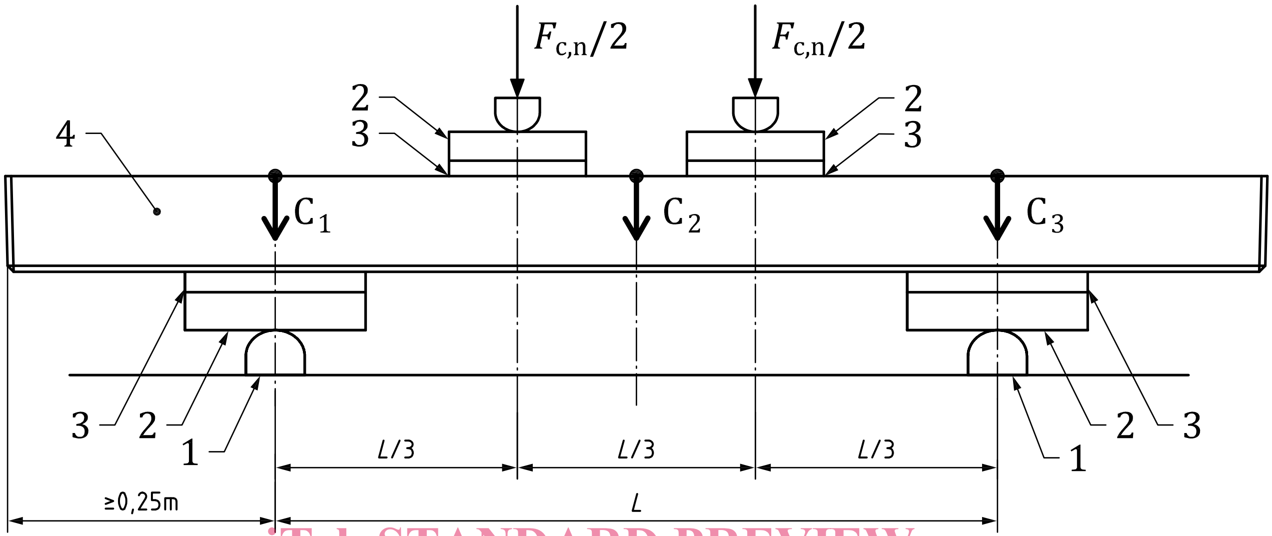
— with direct support of the rail (i.e. fastening system without a baseplate),

is shown in Figure 1. The value of L_r in relation to L_p is detailed in Table 2.

The load, F_r, is applied perpendicularly to the base of the bearer.

The end of the bearer opposite to the end being tested shall be supported during the test in order to compensate the influence of the weight of the bearers on the test bending moment. Alternatively, the bearer may be cut off at the distance, L_p, from the centre line of the rail.

5.2.1.5 Centre section for the negative load test for bearers



Key

1 rigid support

2 articulated support and steel plate (minimum length: bottom width of the sleeper at the rail seat +20 mm, width: 140 ± 01 mm, thickness: minimum 12 mm and minimum hardness Brinell: HBW > 240)

3 resilient pad (minimum length: bottom width of the sleeper at the rail seat + 20 mm, width: $140\ ^{+10}_{0}$ mm, thickness: $15\ ^{+2}_{-3}$ mm and static bedding modulus: static secant bedding modulus measured between 0,3 MPa and 2 MPa: $1 \leq C \leq 4$ N/mm^3)

4 polymeric composite bearer without the fastening system and with the baseplate (if used)

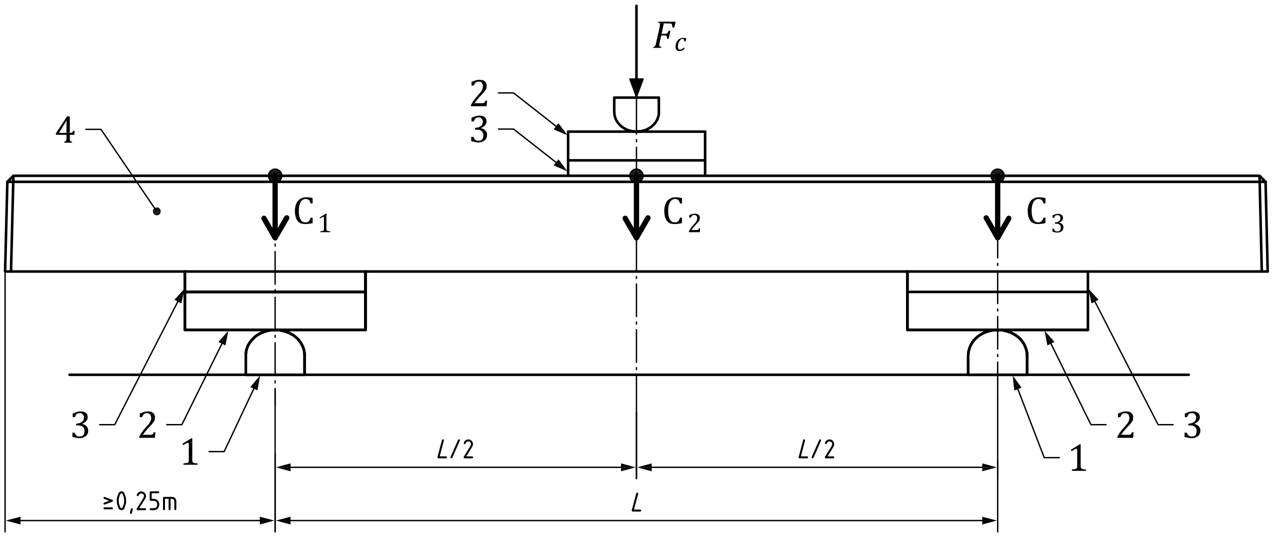
L_C for gauges of 1 435 mm, L = 1,5 m. For other gauges, the length shall be adapted

C_1, C_2 and C_3 locations of the vertical displacement measurement on the axis of the articulated support

$F_{c,n}$ negative test load at the centre section of the sleeper

Figure 4 — Test arrangement at the centre section for the negative load test

5.2.1.6 Centre section for the positive load test for bearers



Key

1	rigid support
2	articulated support and steel plate (minimum length: bottom width of the sleeper at the rail seat +20 mm, width: 140 ± 1 mm, thickness: minimum 12 mm and minimum hardness Brinell: HBW > 240)
3	resilient pad (minimum length: bottom width of the sleeper at the rail seat + 20 mm, width: 140 $^{+10}_{0}$ mm, thickness: 15 $^{+2}_{-3}$ mm and static bedding modulus: static secant bedding modulus measured between 0,3 MPa and 2 MPa: 1 ≤ C ≤ 4 N/mm^3)
4	polymeric composite bearer without the fastening system and with the baseplate (if used)
L	for gauges of 1 435 mm, *L* = 1,5 m. For other gauges, the length shall be adapted
C_1, C_2 and C_3	locations of the vertical displacement measurement on the axis of the articulated support
F_c	positive test load at the centre section of the sleeper

Figure 5 — Test arrangement at the centre section for the positive load test

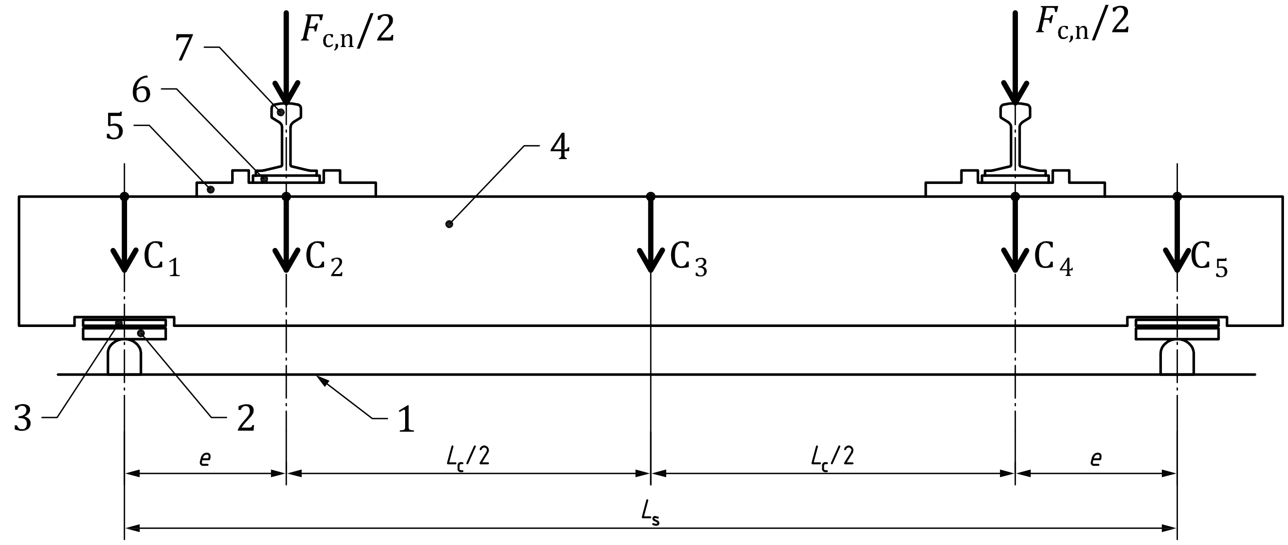
5.2.1.7 Centre section for the load test for transom

The test arrangement shall be approved by the purchaser, depending on the bridge.

NOTE This test arrangement generates positive or negative bending moments depending on the eccentricity, *e*, of the supports on the longitudinal girders of the bridge. However, this test arrangement is only used for the tests in 5.2.3, "Test procedures at the centre section for the negative bending moments".

If support conditions for the transoms on the bridge are different to the test arrangement in Figure 6, this should be taken into account in the calculation of $M_{k,b}$.

Any modification (for example cut-outs to fasten the transom) should be carried out on the transom before testing.



Key

1	rigid support
2	articulated support and steel plate (minimum length: bottom width of the sleeper at the rail seat +20 mm, width: 140 ± 1 mm [this width can be reduced in line with the real width of the rail foot used in track], thickness: minimum 12 mm and minimum hardness Brinell: HBW > 240)
3	resilient pad (minimum length: bottom width of the sleeper at the rail seat + 20 mm, width: 140 $^{+10}_{0}$ mm, thickness: 15 $^{+2}_{-3}$ mm and static bedding modulus: static secant bedding modulus measured between 0,3 MPa and 2 MPa: 1 ≤ C ≤ 4 N/mm^3)
4	transom
5	rib plate as defined by the purchaser
6	standard rail pad as defined by the purchaser
7	rail as defined by the purchaser
e	design distance between the centre line of the rail seat to the longitudinal girders of bridge
L_S	length between the supports on the longitudinal girders of the bridge
C_1, C_2, C_3, C_4 and C_5	locations of the vertical displacement measurement on the axis of the articulated support
$F_{c,n}$	negative test load at the centre section of the sleeper
L_c	design distance between centre lines of the rail seat

Figure 6 — Test arrangement at the centre section for the load test

The deformation, d, measured during the tests on the rail seat is calculated with the Formulae (2), (3) and (4):

$$d = C_2 - \left[C_5 + (C_1 - C_5) \cdot \frac{L_s - e}{L_s} \right] \text{ (at left rail seat)} \qquad (2)$$

$$d = C_4 - \left[C_5 + (C_1 - C_5) \cdot \frac{e}{L_s} \right] \text{ (at right rail seat)} \qquad (3)$$

$$d = C_3 - \frac{(C_1 + C_5)}{2} \text{ (at sleeper centre)} \qquad (4)$$

