



BSI Standards Publication

Railway infrastructure — Rail fastening systems — Two directional test method for resistance to repeated loading

National foreword

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Railway infrastructure — Rail fastening systems — Two directional test method for resistance to repeated loading

*Infrastructure ferroviaire — Systèmes d'attache — Méthode
d'essai bidirectionnel pour la détermination de résistance aux
charges répétitives*

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Foreword

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Railway infrastructure — Rail fastening systems — Two directional test method for resistance to repeated loading

1 Scope

This document describes a test procedure for the determination of resistance to repeated loading by – amongst others – applying out-of-phase load cycles which generate forces in two directions, representative of those caused by traffic on railway track, taking into account the effect of two consecutive axles of passing railway vehicles.

The document applies to surface mounted rail on sleepers, bearers and slab track.

The test procedure applies to a complete fastening assembly.

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 22074-1, *Railway infrastructure — Rail fastening systems — Part 1: Vocabulary*

ISO 22074-2, *Railway infrastructure — Rail fastening systems — Part 2: Test method for longitudinal rail restraint*

ISO 22074-4:2022, *Railway infrastructure — Rail fastening systems — Part 4: Test methods for resistance to repeated loading*

ISO 22074-7, *Railway infrastructure — Rail fastening systems — Part 7: Test method for clamping force and uplift stiffness*

ISO 22074-8:2022, *Railway infrastructure — Rail fastening systems — Part 8: Test method for vertical stiffness*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 22074-1 apply.

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

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <https://www.electropedia.org/>

4 Symbols

Symbol	Description	First appearance
h_N	height of loading position for normal rail, in mm;	6.2
h_T	height of loading position for test rail, in mm;	6.2
P_0	clamping force, in kN;	8.3
F	maximum axial load on the rail without non-elastic displacement occurring, in kN;	8.4
F_{SA1}	the lower limit of force for determining the static stiffness, in kN;	8.5

Symbol	Description	First appearance
$F_{SA \max}$	the reference force for measurement of static stiffness, in kN/mm;	8.5
k_{SA}	vertical stiffness of fastening assembly, in kN/mm;	8.5
k_{LA}	lateral stiffness of fastening assembly, in kN/mm;	8.6
e_T	eccentricity of loading position from centre for test rail, in mm;	8.8.1
θ_A	test loading angle applied from gauge side (A load), in radians;	8.8.1
θ_B	test loading angle applied from field side (B load), in radians;	8.8.1
P_A	test load applied from gauge side (A load), in kN;	8.8.2
$P_{A \max}$	maximum test load applied from gauge side, in kN;	8.8.2
$P_{A \min}$	minimum test load applied from gauge side, in kN;	8.8.2
P_B	test load applied from field side (B load), in kN;	8.8.2
$P_{B \max}$	maximum test load applied from field side, in kN;	8.8.2
$P_{B \min}$	minimum test load applied from field side, in kN;	8.8.2
d_L	lateral rail head displacement, in mm;	8.8.3
d_{LH}	measured lateral displacement at test rail head, in mm;	8.8.3
d_{LF}	measured lateral displacement at test rail foot, in mm;	8.8.3
φ_{TR}	tilting angle of test rail, in radians;	8.8.3
h_{TR}	distance between two measuring points of lateral displacement, in mm;	8.8.3
Q	static wheel load for design, in kN;	B.2
Q_A	vertical component of the design load A (A load), in kN;	B.2
Q_B	vertical component of the design load B (B load), in kN;	B.2
Y_A	lateral component of the design load A (A load), in kN;	B.2
Y_B	lateral component of the design load B (B load), in kN;	B.2
k_v	total vertical stiffness per unit length, in kN/mm/m;	B.2
k_{SB}	vertical stiffness of rail supporting structure, in kN/mm;	B.2
k_h	total lateral stiffness per unit length, in kN/mm/m;	8.2
k_{LB}	lateral stiffness of rail supporting structure, in kN/mm;	B.2
W_A	vertical component of the test load A (A load), in kN;	B.2
W_B	vertical component of the test load B (B load), in kN;	B.2
H_A	lateral component of the test load A (A load), in kN;	B.2
H_B	lateral component of the test load B (B load), in kN;	B.2
A	sleeper spacing, in m;	B.2
El_x	vertical bending rigidity of normal rail, in kN·m ² ;	B.2
El_y	lateral bending rigidity of normal rail, in kN·m ² ;	B.2
φ_A	rail tilting angle at the loading point for design load A, in radians;	B.3
φ_B	rail tilting angle at the loading point for design load B, in radians;	B.3
M_A	tilting moment of rail against the design load A, in kN·m;	B.3
M_B	tilting moment of rail against the design load B, in kN·m;	B.3
C	torsional rigidity of the normal rail, in kN·mm ² /radian;	B.3
e_N	eccentricity of loading position from centre for normal rail, in mm;	B.3
K'	torsional spring constant of the rail fastening system, in kN·m/radian;	B.3
K_1	stiffness of rail pad, in kN/mm;	B.3
K_2	lower uplift stiffness of rail clip, in kN/mm;	B.3
K_3	higher uplift stiffness of rail clip, in kN/mm;	B.3
P_0	initial clamping force, in kN;	B.3
P_1	clamping force due to Q , Q_A or Q_B , in kN;	B.3

Symbol	Description	First appearance
P_1'	clamping force on gauge side, in kN;	B.3
P_1''	clamping force on field side, in kN;	B.3
δ	deflection of rail clip fastened on gauge side corresponding to $(P_1' - P_0)$, in mm;	B.3
d_0	deformation of rail pad due to application of P_0 , in mm;	B.3
d_1	deformation of rail pad due to application of Q , Q_A or Q_B , in mm;	B.3
b_1	width of rail pad, in mm;	B.3
b_2	lateral distance between two clamping point, in mm;	B.3
φ_0	rail tilting angle at the loading point, in radians;	B.3
φ_1	rail tilting angle when clamping force is equal to initial clamping force, in radians;	B.3
φ_2	rail tilting angle when rail end begins to leave from rail pad, in radians;	B.3
X	width where bottom of the rail and the rail pad touch, in mm;	B.3
Y	deflection of rail bottom surface caused by increase in clamping force, in mm.	B.3

5 Principle

Static and repeated loads of a constant amplitude are applied by a pair of actuators operating out of phase with each other. This two directional loading testing is applicable when the fastening system is applied on the railway track where out of phase lateral forces occur.

The test method for repeated loading is largely similar to the method defined in ISO 22074-4.

The test sequence is as shown in [Figure 1](#).

First a normal rail is adopted for collecting data for calculating test loads.

Then a modified test rail is adopted in the two directional static load test and the repeated load test, described in [8.8](#) and [8.9](#).

The test method cannot be applied to fastening systems which are based on web-supported rails nor to embedded rails because they cannot be tested with modified test rails.

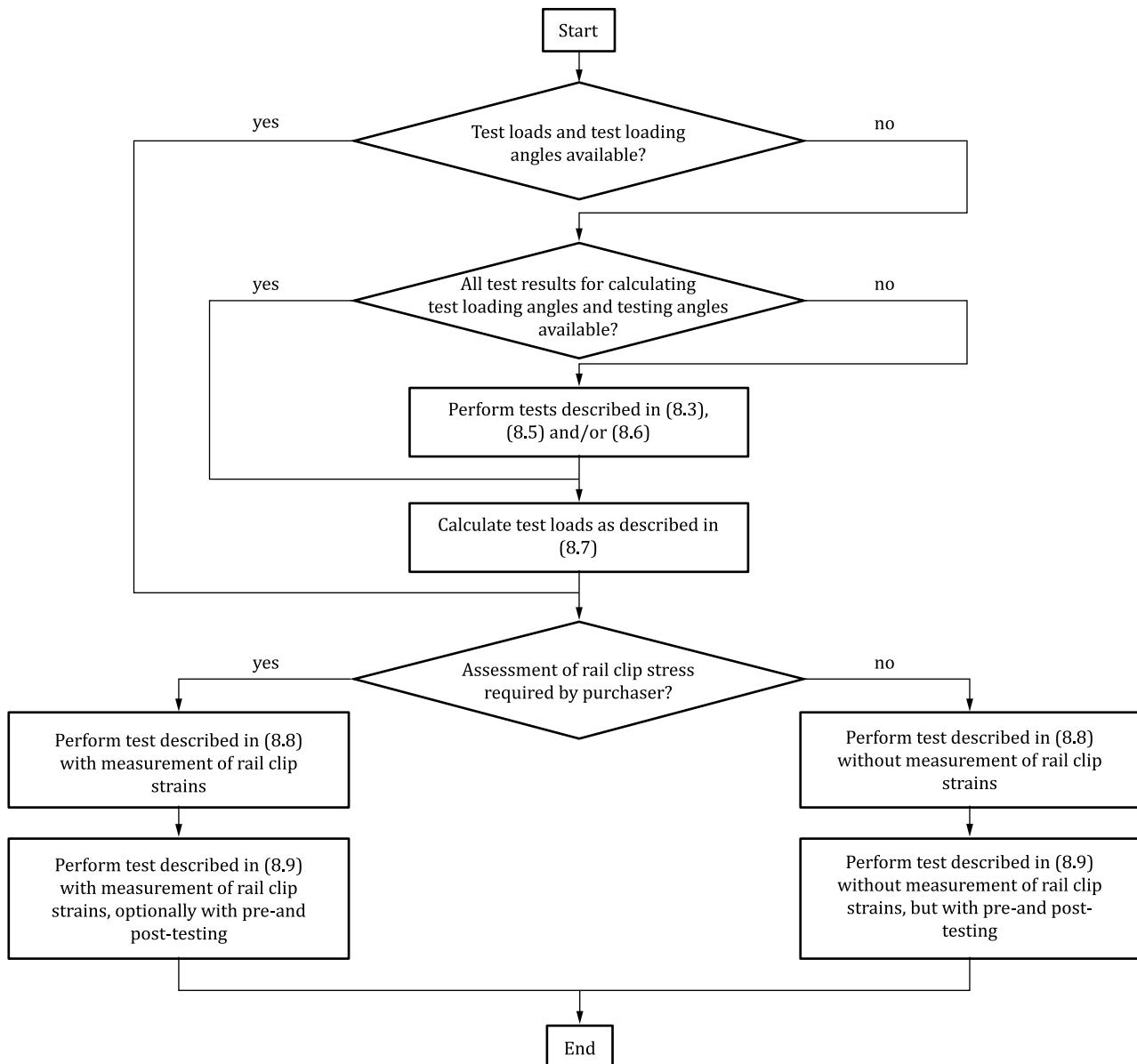


Figure 1 — Diagram of test sequence

6 Apparatus

6.1 General arrangement

The complete test procedure refers to several tests, for which specific test standards are applicable, which define the specific test arrangements.

The arrangement for the two directional tests is described in [8.8](#) and [8.9](#).

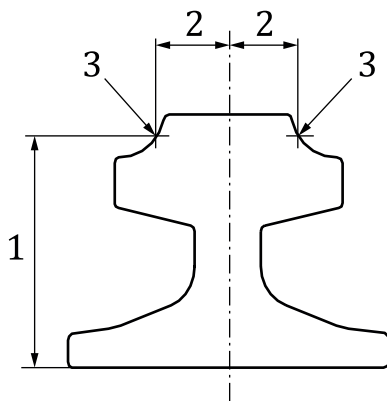
6.2 Rail

All fastening assemblies used in the tests shall make use of a section of rail with a length of approximately 0,5 m and which shall be unlaminated and have neither loose rust on the surface nor be polished on the foot.

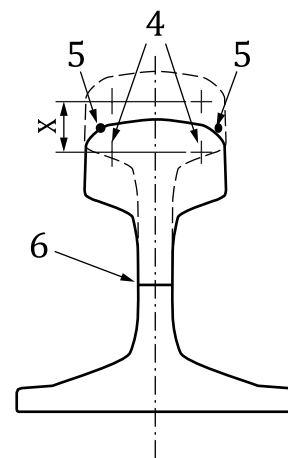
Use one of load application arrangement of the test rail shown in [Figure 2](#). The test rail used in the two directional tests, as described in [8.8](#) and [8.9](#), has the following features:

- The test rail with modified rail head (to accommodate the load application head) and shortened rail web shall be as shown in [Figure 2 a\)](#). The curve radius at the load application point is 15 mm unless otherwise specified. The eccentricity of loading position from rail centre, e_T , is 30 mm unless otherwise specified.
- The test rail with partially removed rail web shall be as shown in [Figure 2 b\)](#). The value X is the difference between the height of loading position for the normal rail, h_N , and that for the test rail, h_T .
- The foot of the test rail shall be identical to the foot of the normal rail used in service.
- The height of the loading position for test rail, h_T , is obtained using the process of calculation described in [Annex B](#).

NOTE A normal rail is the rail for which the fastening assembly is designed.



a) Modified rail head and shortened rail web



b) Partially removed rail web

Key

- 1 height of loading position for test rail, h_T
- 2 eccentricity of loading position from rail centre, e_T
- 3 curve radius at loading position
- 4 centre of gauge corner radius
- 5 point of load application
- 6 part of web removed

Figure 2 — Test rails

6.3 Actuator

Specifications for the actuators used in each of the tests described in [8.3](#), [8.4](#), [8.5](#) and [8.6](#) shall be taken from the test standards referenced in these subclauses.

The two actuators used in the two directional tests, as described in [8.8](#) and [8.9](#), have the following features:

- They shall each be capable of applying a force of up to 160 kN static as well as dynamic in a cyclical manner at a frequency of 5,5 Hz. Hydraulic control of actuators shall be done so that the resultant vertical components of load applied to the fastening assembly decreases to nearly 0 kN.
- The actuator equipment shall be able to apply the test load on the test loading angle with a tolerance of $\pm 1,0$ degrees. In other words, the actuator shall have a hinge to meet the required test loading angle.