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Railway infrastructure — Rail fastening systems —

Part 4: Test methods for resistance to repeated loading

Infrastructure ferroviaire — Systèmes de fixation du rail —

Partie 4: Méthode d'essai pour la détermination de résistance aux charges répétitives

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Contents

Page

Foreword

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

A list of all parts in the ISO 22074 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.

Railway infrastructure — Rail fastening systems —

Part 4:
Test methods for resistance to repeated loading

1 Scope

This document specifies a laboratory test procedure for applying repeated load cycles which generate displacement cycles representative of the displacements caused by traffic on railway track. It is used for assessing the long-term performance of rail fastening systems.

This document is applicable to surface mounted rail on sleepers, bearers and slab track and embedded rail.

This 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 22074-7, *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*

ISO 7500-1:2018, *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 9513, *Metallic materials — Calibration of extensometer systems used in uniaxial testing*

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/

3.1
performance requirement
requirement relating to applied loading and pass/fail criteria identified before the test is carried out

Note 1 to entry: These requirements can be set out in a client's technical specification or in standards such as the EN 13481 series or EN 17319.

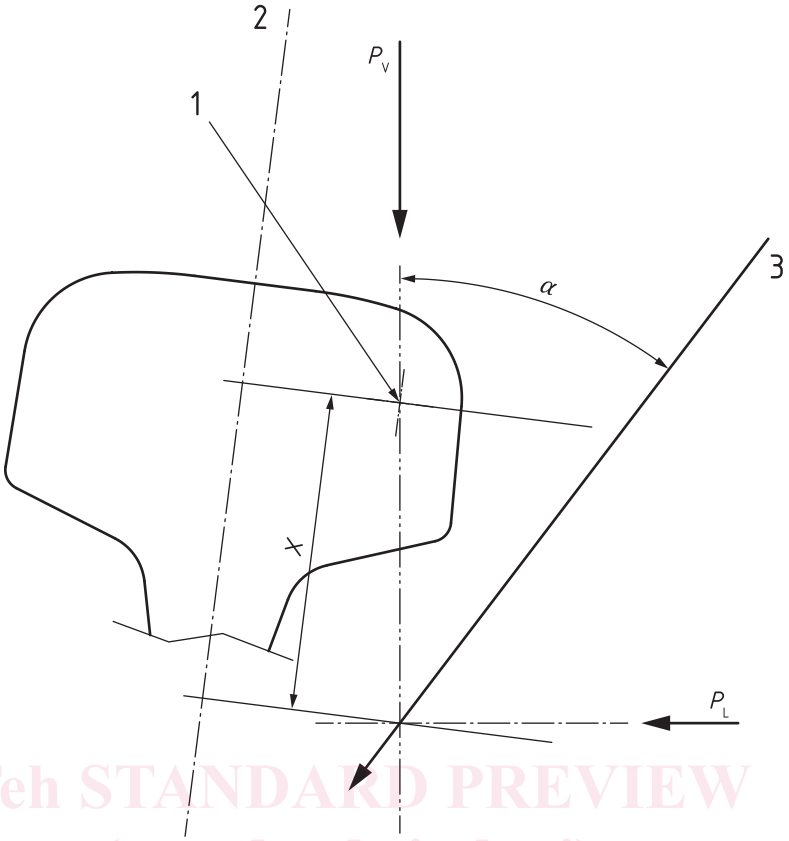
4 Symbols

For the purposes of this document, the following symbols apply.

α	angle between the load line and a line normal to the datum surface of the rails	°
F	longitudinal restraint i.e. maximum axial longitudinal load on the rail without non-elastic displacement occurring	kN
F_{SAmax}	force applied to the assembly in measurement of static stiffness of the assembly	kN
F_{SA1}	lower limit of force for determining the static stiffness of assembly	kN
F_{SA2}	upper limit of force for determining the static stiffness of assembly	kN
P_{max}	maximum load applied by the actuator during the repeated load test	kN
P_{min}	minimum load applied by the actuator during the repeated load test	kN
P_L	component of force parallel to the datum surface of the rails	kN
P_V	component of force normal to the datum surface of the rails	kN
X	position of the line of application of P_L below the centre of curvature of the gauge corner of the rail head as shown in Figure 1	mm

NOTE 1 $\frac{P_L}{P_V} = \tan\alpha$

NOTE 2 Datum surface is defined in ISO 22074-1.



Key

1 centre of gauge corner radius
2 centre line of the rail profile
3 line of load application

Figure 1 — Position of load application

5 Test procedure

5.1 General principle

A constant amplitude, cyclic force is applied at a predetermined load line and position on the rail head. The magnitude, inclination and point of application of the load to be used are determined from the stiffness of the fastening assembly, axle loads and curve conditions of the track for which the fastening assembly is being tested.

A constant amplitude, cyclic force is applied by a single actuator.

Performance is determined by the change in clamping force, longitudinal rail restraint, vertical stiffness and rail position, and visual inspection of the components during test.

If the test conditions are dependent on the dynamic low frequency stiffness of the fastening system, it shall be measured before the repeated load test procedure set out in 5.4 or 5.5, following the procedure of ISO 22074-8:2022, 7.2.

NOTE For the reference test method described in Clause 5, guidance on the derivation of loads and loading geometry is included in CEN/TR 17320.

5.2 Apparatus

5.2.1 Rail

Short lengths of rail (approximately 0,5 m per rail seat or longer if required), of the section for which the fastening assembly under test is designed shall be used. The rail shall be unlaminated and neither have loose rust on the surface nor be polished on the foot.

The head of the rail can be modified to accommodate the load application except when testing fastenings which support the web of the rail. The dimension *X*, as shown in Figure 5, refers to the design rail section for the fastening assembly.

For embedded rail, the rail is part of the test specimen and its length is specified in 5.3.1.

5.2.2 Actuator

An actuator capable of applying a force of up to 150 kN in a cyclic manner at a frequency of (4 ± 1) Hz shall be used.

NOTE For simultaneous loading of two and four rail seats, the required capacity is correspondingly greater.

5.2.3 Load application head

A head in contact with the rail which is capable of transmitting the applied force to a rail at the required position relative to the rail head shall be used.

5.2.4 Displacement measuring instruments

5.2.4.1 Calibration procedure

If contacting displacement measuring instruments are used, they shall conform to ISO 9513.

If non-contacting displacement measuring instruments are used, they shall be calibrated to ensure that they are capable of measuring the displacement of the rail, relative to the supporting sleeper or other element as required in 5.2.4.2.

5.2.4.2 Calibration requirement

The instrument shall be capable of measuring displacements as follows:

— for assemblies with an expected dynamic low frequency stiffness ≤100 MN/m, displacement measurement within ±0,02 mm;

— for assemblies with an expected dynamic low frequency stiffness >100 MN/m, displacement measurement within ±0,01 mm.

5.2.4.3 Fixtures for mounting displacement measuring instruments

For measurement of displacements during repeated loading, mounting fixtures shall be provided which minimize additional measurement errors under the conditions within which the test is running.

When displacements are to be measured while the test is running, steps should be taken to ensure that any fixtures used to support the displacement measuring instruments are short and stiff. This is to ensure that the dynamic response of the fixture does not affect significantly the accuracy or repeatability of the measurements.

5.2.5 Force measuring instruments

5.2.5.1 Instruments

Instruments conforming to ISO 7500-1:2018, Class 1 and over the required range of force shall be used.

5.2.5.2 Verification of calibration

The calibration of actuators shall be verified periodically in accordance with ISO 7500-1 using equipment having traceability to International Standards using the International System of Units (SI).

5.3 Test specimens

5.3.1 Sleeper or other rail support

A sleeper, half sleeper, concrete block or other rail support with cast-in fastening components or holes, and rail seats, as made without modification for this test shall be used. Two sleepers or half sleepers should be used if the cast-in fastening components or holes are non-symmetrical about the longitudinal centre line of the sleeper.

For surface mounted rail on ballastless track, the fastening system (or two fastening systems if required: see 5.4.2.2) shall be mounted centrally on the top of a reinforced concrete block. The length and width of the block shall be large enough to support the area of the fastening system or systems as they would be supported in use in track, and to extend at least 100 mm around any component which is embedded into the block. The depth of the block shall be the depth of the slab or (230 ± 10) mm, whichever is the smaller.

For surface mounted rail on ballastless track, with continuous support of the rail, the test shall be performed using a length of pad equal in length to the design spacing of the fastening along the rail. The piece of rail used for the test shall be at least as long as the piece of pad; and the size of the concrete block shall be sufficient to provide support to the full length of the piece of pad.

For embedded rail, the channel containing the rail shall be contained in a concrete block similar to that for surface mounted rail on sleepers, bearers and slab track. The length of embedment shall be the typical spacing of fastenings for the relevant fastening category; and the piece of rail used for the test shall be at least as long as the embedment.

5.3.2 Fastening

All fastening components as used in track shall be assembled in accordance with the manufacturer's instructions.

5.4 Procedure for one rail

5.4.1 General

The following procedure is for the test when a rail is fixed to one end of the sleeper or half sleeper. When two rails are used, the procedure in 5.5 shall be used.

The sequence of tests shall be 5.4.3, 5.4.4, 5.4.5, 5.4.6, 5.4.5, 5.4.4, 5.4.3 performed on test specimens assembled in accordance with 5.3. At no time during the test sequence shall any part of the fastening assembly or the rail be adjusted, retightened or modified.

5.4.2 Preparation for test

5.4.2.1 Single rail seat

Fix a short length of rail to one rail seat using the fastening components as assembled in track.

5.4.2.2 Two rail seats

If the fastenings are non-symmetrical, the test setup can become unstable during the repeated load test. Alternatively, it can be necessary to test two rail seats together as set out in ISO 22074-2. In such cases, fix a short length of rail to one rail seat on each of two adjacent sleepers or other rail supports as shown in Figure 2.

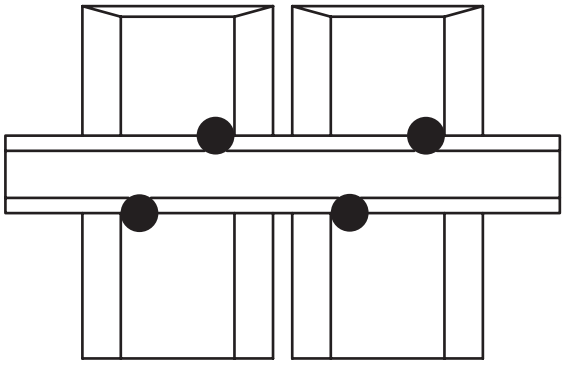


Figure 2 — Arrangement for testing two rail seats

When testing two fastening assemblies together, the effect of bending of the rail should be minimized. This can be done by either or both of the following:

a) placing the two fastening systems as close together as possible;

b) using a "spreader beam" to distribute the load equally between the two fastening assemblies.

5.4.3 Clamping force

Determine the clamping force of the assembly using the procedure in ISO 22074-7.

If the test is carried out on two rail seats, the vertical force is applied midway between the two rail seats. The clamping force is taken as half of the total force applied across two rail seats.

5.4.4 Longitudinal rail restraint

Determine the longitudinal rail restraint or longitudinal stiffness, as appropriate, using the procedure in ISO 22074-2.

If the test is carried out on two adjacent rail seats as described in 5.4.2.2, the result shall be expressed per rail seat, thus as half of the force measured for two rail seats.

The tensile load applied to the rail before and after the repeated load test shall be in the same direction.

5.4.5 Vertical static stiffness of fastening assembly

For one rail fastening assembly, follow the procedure of ISO 22074-8.

If the specimen includes two rail fastening assemblies, follow the same procedure but all loads and loading rates shall be doubled, i.e. test between $2F_{SA1}$ and $2F_{SA2}$ = $1{,}6F_{SAmax}$ at a loading rate of (240 ± 20) kN/min.

5.4.6 Cyclic loading

5.4.6.1 Preparation for the repeated load test

Obtain the specified values of P_V, α and X from the performance requirements for the fastening category for which the rail fastening system is intended.

NOTE Performance requirements are set out, for example, in the EN 13481 series.

Set up the test arrangement as shown in Figure 3 or, when appropriate, Figure 4, with the base of the test specimen supported on a rigid surface with a layer of plywood, gypsum board or other conformable material between the specimen and support. The sleeper, half sleeper or block (item 1 in Figure 3) shall be fixed in position.

Use one of the load application arrangements shown in Figure 5 without any modification to the rail foot. The load application strut shall have a width parallel to the longitudinal axis of the rail of not less than 90 mm. The radius of curvature, normal to the rail head, shall be greater than the radius of the contact surface of the rail such that the strut maintains a line contact with the rail under all load conditions.

When testing embedded rail or fastening systems which act on the web of the rail, an unmodified rail section shall be used.

If the test specimen comprises two fastening assemblies, as recommended in 5.4.2.2, the application point of the load shall be chosen in order to distribute the loading equally between the two assemblies.

The repeated load to be used in this test for a single rail fastening assembly shall be between a minimum load, P_{min}, of (5 ± 1) kN and a maximum load, P_{max}, of [(P_V/cos α) ± 1] kN.

The repeated load to be used in this test on two adjacent rail fastening assemblies shall be between a minimum load, P_{min}, of (10 ± 1) kN and a maximum load, P_{max}, of [(2P_V/cos α) ± 1] kN.

5.4.6.2 Preliminary load cycles

Apply an alternating load to the test specimen between P_{min} and P_{max} for 1 000 cycles at (4 ± 1) Hz. Stop the test and with the load P_{max} applied, check that the resultant force is acting within the tolerances (α ± 0,5)° and (X ± 1) mm. If the resultant force is not acting within these tolerances, the test rig shall be readjusted and the test restarted.

Reduce the applied load to P_{min} and then set all displacement measuring instruments to zero at this point in order to establish a datum for all subsequent measurements.

5.4.6.3 Continuation of the repeated load test

Reapply the same alternating load to the test specimen between P_{min} and P_{max} at a frequency of (4 ± 1) Hz, for 3 × 10^6 cycles (excluding the 1 000 cycles performed in 5.4.6.2). Within the first 1 000 cycles of the continuation of the repeated load test and within the last 1 000 cycles before the test is completed, measure the dynamic displacements as shown in Figure 6 for at least one loading cycle.

The displacement measuring instruments shall not be readjusted or reset at any time during the continuation of the repeated load test.

If contacting displacement transducers are used, the contacting probe may be held back from the rail when the displacement is not being recorded but care shall be taken to ensure that the transducer itself remains fixed in position.

During this test, the maximum temperature of any component shall not exceed 50 °C. Cooling by a fan or a slight reduction in frequency within the permitted (4 ± 1) Hz range or a temporary stop with the load held at P_{min} can be used to avoid overheating.