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Railway infrastructure — Rail fastening systems —

Part 7: **Test method for clamping force and uplift stiffness**

Infrastructure ferroviaire — Systèmes de fixation du rail —

Partie 7: Méthode d'essai pour la détermination de l'effort d'application au patin du rail et la rigidité au soulèvement

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Foreword

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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.

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Railway infrastructure — Rail fastening systems —

Part 7:
Test method for clamping force and uplift stiffness

1 Scope

This document specifies the laboratory test procedure for determining the clamping force exerted by the fastening system on the foot of the rail by measuring the force to separate the rail foot from its immediate support. When required, the procedure is also used to determine the uplift stiffness of the fastening system.

It is applicable to systems with and without baseplates on all types of sleepers, bearers or elements of ballastless track. The test does not determine the security of the fastening components fixed into the sleeper or other fastening system support.

This test procedure applies to a complete fastening assembly. It is not applicable to fastening systems for embedded rail or other fastening systems which do not act on the foot of the rail.

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 7500-1:2018, *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 22074-1, *Railway infrastructure — Rail fastening systems — Part 1: Vocabulary*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 22074-1 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 https://www.electropedia.org/

4 Symbols

Symbol	Description	Unit
d	for direct fastening systems – vertical displacement of the rail relative to the sleeper for indirect fastening systems – vertical displacement of the rail relative to the baseplate	mm
d_{lim}	limiting uplift displacement beyond which the fastening is very stiff (effectively rigid)	mm

m_s	mass of sleeper or part sleeper and fastening components fixed to it, used in the test	kg
m_f	mass of loading frame supported by the sleeper	kg
P	vertical load applied to the rail	kN
P_c	initial estimate of clamping force	kN
P_{lim}	vertical load required to reach limiting uplift displacement, d_{lim}	kN
P_0	vertical load at zero rail displacement which just counteracts the clamping force	kN
P_1	vertical load at zero displacement which, combined with the weight of the sleeper, just counteracts the clamping force	kN

5 Principle

The clamping force for a complete rail fastening assembly is determined by measuring the force necessary to separate the rail from the surface on which it is supported.

6 Apparatus

6.1 Rail, of short length, of the section for which the fastening assembly under test is designed.

6.2 Loading device, to apply a vertical load to the rail (reference method) or sleeper (alternative method) at a controlled rate of approximately 10 kN/min.

NOTE Throughout this document the orientation of the applied force, described as "vertical", "upward" or "downward" is in line with the vertical axis of the rail.

6.3 Measuring and recording instruments, measuring the vertical displacement of the rail support (baseplate or sleeper) relative to the rail with an accuracy of ±0,1 mm and instruments conforming to ISO 7500-1:2018, Class 1, which measure the applied force. The recording instruments shall be capable of plotting load-displacement diagrams.

The calibration of actuators and measuring instruments shall be verified periodically with equipment conforming to relevant local or international standards

6.4 Steel shims, with dimensions 25 mm × 25 mm × 0,25 mm, with maximum thickness 0,30 mm.

7 Test specimens

7.1 Rail support

A portion of a sleeper, bearer or a concrete block whose centroid is approximately at the centre line of the rail seat or baseplate support area. This is described as a sleeper in the test procedure.

7.2 Fastening

All fastening components, as used in track, including baseplates where incorporated.

8 Test procedure (reference method)

8.1 Preparation for test

Fix the rail to the sleeper, with the baseplate if part of the assembly, using the fastening components assembled as in track. If the test is to be conducted on an indirect fastening system, the clamps may be fixed over the baseplate provided that movement of the rail relative to the baseplate is not constrained.

If a rail pad is used which is shaped to provide positive location in the assembly, the edges of the pad may be cut off to simplify removal of the pad. The portion of the pad under the rail shall not be cut.

NOTE For fastening assemblies for switches and crossings which incorporate long baseplates additional fixings can be made into the supporting bearer or slab to minimize bending of the baseplate during this test.

Clamp the portion of sleeper to the base of the test fixture. Set up the test arrangement as shown in Figure 1 to permit a load, P, to be applied to the rail normal to the rail seat. Locate one displacement transducer at each of the four corners of the rail seat to measure d. Zero the displacement transducers.

8.2 Loading and measurement for assemblies incorporating a rail pad

Apply an increasing tensile load P to the rail, ensuring that the rail base is kept parallel to the rail seat without tilting, until the pad can just be moved. Remove the pad and decrease the load until the average of the displacement transducers is zero. At this point the $P = P_c$. Record the load, P_c, and then reduce the load to approximately $0{,}9P_c$. Whilst recording d (the average of the four transducers) increase the load, P, at a rate of (10 ± 1) kN/min until the load is $1{,}1P_c$. From the load-displacement diagram (see Figure 2) read off the value of P_0 at $d = 0$ which is taken as the clamping force. On the same test specimen, and without changing or adjusting any components, repeat the loading and unloading sequence twice more and calculate the mean clamping force.

8.3 Loading and measurement for assemblies not incorporating a rail pad

Apply an increasing tensile load, P, to the rail until there is a clear space under the rail which is just sufficient to allow insertion of four steel shims under the rail, one at each corner of the rail seat. Reduce the load, P, to zero and then reapply an increasing load until a value is reached at which it is just possible to move all the shims by hand. This load is P_0 which is taken as the clamping force. Repeat the procedure twice more and calculate the mean clamping force as the average of the three values of P_0 obtained.

8.4 Determination of uplift stiffness

When required, the uplift stiffness of the spring clip components of the rail fastening system may be determined as the secant stiffness between the load limits of $0{,}9P_c$ and $1{,}1P_c$ as indicated in Figure 2.

In fastening systems which include a physical limit to the amount of uplift displacement which may be applied, the force, P_{lim}, and displacement, d_{lim}, required to reach that limit shall be recorded. (see Figure 3)

NOTE Where there is significant elasticity in other elements of the fastening system, e.g. between a baseplate and the supporting element or under a rail seat block, the method of 8.4 is not applicable.

8.5 Testing with two baseplated fastening assemblies

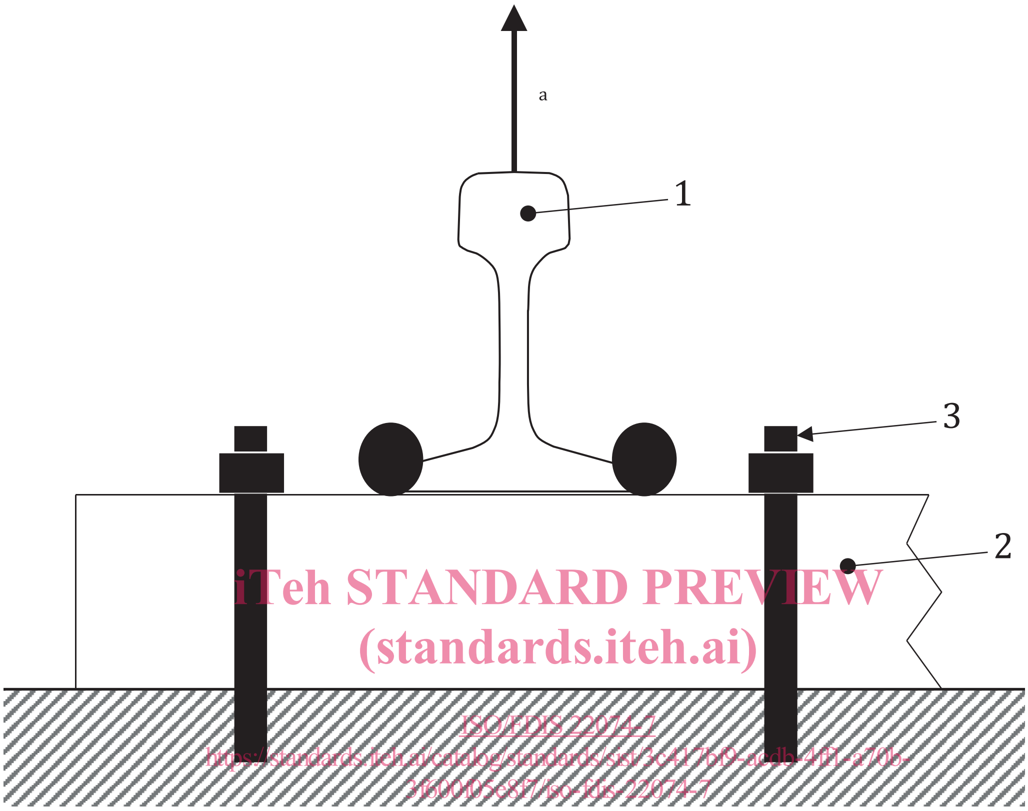
When this test procedure is used in conjunction with the procedure for repeated load testing of asymmetric baseplated fastening systems, according to ISO 22074-4[1)], two fastening systems may be tested together. In this case, the following procedure shall be followed.

The loading apparatus shall be positioned above one of the baseplates. The bolts or screws fixing the other baseplate to the sleeper shall be loosened. The test shall then be conducted according to 8.3.

1) Under preparation. Stage at the time of publication: ISO/DIS 22074-4:2021.

The loading apparatus shall then be positioned above the second baseplate. The bolts or screws fixing the baseplate shall be re-tightened and those fixing the first baseplate loosened. The test shall then be conducted again according to 8.3.

The clamping force or uplift stiffness shall be calculated as the average value of the tests on the two baseplates.



Key

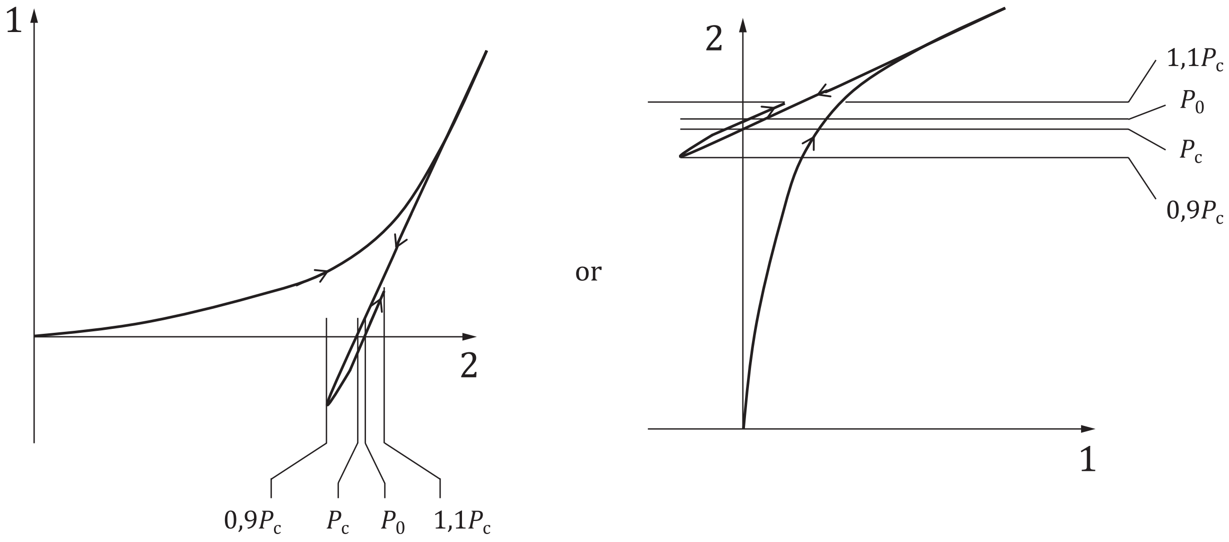
1 rail

2 sleeper

3 retaining bolts or equivalent devices

a Applied load.

Figure 1 — Test arrangement (reference method)

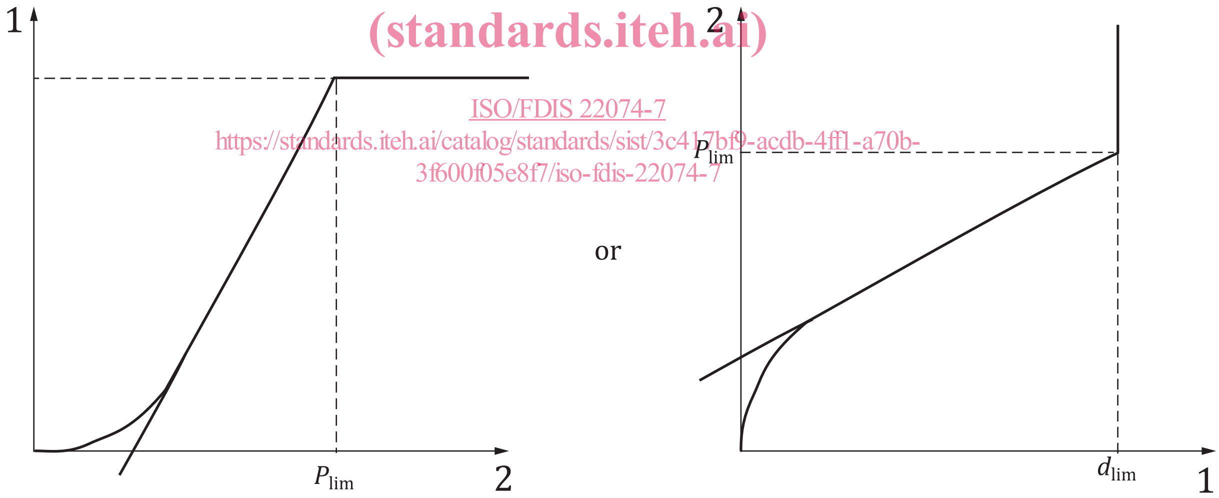


Key

1 displacement, *d*, in mm

2 load, *P*, in kN

Figure 2 — Load/displacement diagram



Key

1 displacement, *d*, in mm

2 load, *P*, in kN

Figure 3 — Definition of limit to uplift displacement

9 Test procedure (alternative method)

9.1 Preparation for test

Fix the rail to the sleeper, with the baseplate if part of the assembly, using the fastening components assembled as in track. If the test is to be conducted on an indirect fastening system, the clamps may be fixed over the baseplate provided that movement of the rail relative to the baseplate is not constrained.

If a rail pad is used which is shaped to provide positive location in the assembly, the edges of the pad can be cut off to simplify removal of the pad. The portion of the pad under the rail shall not be cut.

NOTE For fastening assemblies for switches and crossings which incorporate long baseplates additional fixings can be made into the supporting bearer or slab to minimize bending of the baseplate during this test.

Support the rail so that the sleeper is suspended from it as shown in Figure 4. Set up the loading frame as shown in Figure 4 with two displacement transducers set up, one on each side of the rail on the baseplate (if used) or sleeper. These instruments shall be kept parallel to the rail foot, particularly at the zero reading, by careful sectioning of the sleeper or by adding balance weights. Four transducers shall be used around the rail seat to monitor sleeper movement.

9.2 Loading and measurement for assemblies incorporating a rail pad

Apply an upward force to the frame to negate the effect of the weight of the frame and sleeper on the fastening. Set the displacement measuring transducers to zero. Remove the upward force.

Apply an increasing downward load P to the loading frame, ensuring that the rail base is kept parallel to the rail seat without tilting, until the pad can just be moved. Remove the pad and decrease the load until the average of the displacement transducers is zero. At this point the $P = P_c$. Record the load, P_c, and then reduce the load to approximately $0{,}9P_c$. Whilst recording d (the average of the four transducers) increase the load, P, at a rate of (10 ± 1) kN/min until the load is $1{,}1P_c$. From the load-displacement diagram (see Figure 2) read off the value of P_1 at $d = 0$. The clamping force, P_0, in kN, is calculated with Formula (1):

$$P_0 = P_1 - 0{,}009\,8 \times (m_s + m_f) \qquad (1)$$

On the same test specimen, and without changing or adjusting any components, repeat the loading and unloading sequence twice more and calculate the mean clamping force.

9.3 Loading and measurement for assemblies not incorporating a rail pad

Apply an increasing downward load P through the frame until there is a clear space under the rail which is just sufficient to allow insertion of four steel shims under the rail, one at each corner of the rail seat. Reduce the load, P, to zero and then reapply an increasing load until a value is reached at which it is just possible to move all the shims by hand. This load is P_0. The clamping force may then be calculated using the Formula (1) above. Repeat the procedure twice more and calculate the mean clamping force as the average of the three values of P_0 obtained.

9.4 Determination of uplift stiffness

When required, the uplift stiffness of the spring clip components of the rail fastening system may be determined using the same procedure as in 8.4.

