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Železniške naprave - Zgornji ustroj - Preskušanje pritrdilnih sistemov - 9. del: Ugotavljanje togosti

Railway applications - Track - Test methods for fastening systems - Part 9: Determination of stiffness

Bahnanwendungen - Oberbau - Prüfverfahren für Schienenbefestigungssysteme - Teil 9: Bestimmung der Steifigkeiten

Applications ferroviaires - Voie - Méthodes d'essai pour les systèmes de fixation - Partie 9 : Détermination de la raideur

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Railway applications - Track - Test methods for fastening systems - Part 9: Determination of stiffness

Bahnanwendungen - Oberbau - Prüfverfahren für Schienenbefestigungssysteme - Teil 9: Bestimmung der Steifigkeiten

This draft European Standard is submitted to CEN members for enquiry. It has been drawn up by the Technical Committee CEN/TC 256.

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

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European foreword

This document (prEN 13146-9:2018) has been prepared by Technical Committee CEN/TC 256 "Railway applications", the secretariat of which is held by DIN.

This document is currently submitted to the CEN Enquiry.

This document will supersede EN 13146-9:2009+A1:2011.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association.

In this revision of EN 13146-9:2009+A1:2011 the procedures for setting up and calibrating instruments have been brought into line with the requirements in EN 13146-4 and the procedure for high frequency stiffness testing has been moved into an informative annex.

This document is one of the series EN 13146 *Railway applications — Track — Test methods for fastenings systems*, which consists of the following parts:

— *Part 1: Determination of longitudinal rail restraint*;

— *Part 2: Determination of torsional resistance*;

— *Part 3: Determination of attenuation of impact loads*;

— *Part 4: Effect of repeated loading*;

— *Part 5: Determination of electrical resistance*;

— *Part 6: Effect of severe environmental conditions*;

— *Part 7: Determination of clamping force*;

— *Part 8: In service testing*;

— *Part 9: Determination of stiffness*;

— *Part 10: Proof load test for pull-out resistance*.

Introduction

This part of the EN 13146 series brings together test methods for measuring the stiffness of pads and fastening assemblies under static and low frequency dynamic loading.

Earlier versions of this standard included test methods applicable to higher frequencies. These methods are still included in an informative annex.

No method for testing at acoustic frequencies is included. The procedure in EN 15461, which involves testing a length of track incorporating the fastening assemblies under test, is recommended.

1 Scope

This document specifies laboratory test procedures to determine the static and dynamic stiffness of rail pads, baseplate pads and complete rail fastening assemblies.

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.

EN 13146-4, *Railway applications – Track – Test methods for fastening systems – Part 4: Effect of repeated loading*

EN 13481-1:2002, *Railway applications – Track – Performance requirements for fastening systems – Part 1: Definitions*

EN ISO 7500-1:2015, *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 7500-1:2015)*

EN ISO 9513:2012, *Metallic materials – Calibration of extensometer systems used in uniaxial testing (ISO 9513:2012)*

EN ISO 10846-1:2008, *Acoustics and vibration – Laboratory measurement of vibro-acoustic transfer properties of resilient elements – Part 1: Principles and guidelines (ISO 10846-1:2008)*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 13481-1:2002 and EN ISO 10846-1:2008 apply.

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

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

4 Symbols and abbreviated terms

		Relevant subclause
F_{SPmax}	force applied to pad in measurement of static stiffness of pad, in kN;	6.1.3
F_{SP1}	notional fastening clip force assumed for measurement of static stiffness of pad, in kN;	6.1.3
F_{SP2}	0,8 F_{SPmax}, in kN;	6.1.3
k_{SP}	static stiffness of pad, in MN/m;	6.1.3
d_{SP}	mean vertical displacement of pad, in mm;	6.1.3
F_{LFPmax}	reference force for measurement of dynamic low frequency stiffness of pad, in kN;	6.2.3.1

F_{LFP1}	notional fastening clip force assumed for measurement of dynamic low frequency stiffness of pad, in kN;	6.2.4
F_{LFP2}	0,8 F_{LFPmax}, in kN;	6.2.4
d_{LFP}	displacement of pad in measurement of low frequency dynamic stiffness of pad, in mm;	6.2.4
f_{LFP}	frequency of measurement of low frequency measurement dynamic stiffness of pad, in Hz;	6.2.4
k_{LFPf}	low frequency dynamic stiffness of pad at a specific frequency, in MN/m;	6.2.4
$k_{LFPmean}$	mean of measurements of low frequency dynamic stiffness of pad measured at 5 Hz, 10 Hz and 20 Hz, in MN/m;	6.2.4
F_{SAmax}	force applied to assembly in measurement of static stiffness of assembly, in kN;	7.1.4
k_{SA}	static stiffness of assembly, in MN/m;	7.1.4
d_{SA}	mean displacement of rail in measurement of static stiffness of assembly, in mm;	7.1.4
F_{SA1}	minimum force applied in measurement of static stiffness of assembly, in kN;	7.1.4
F_{SA2}	maximum force applied in measurement of static stiffness of assembly = 0,8 $F_{LFAmax,}$ in kN;	7.1.4
k_{LFA}	low frequency dynamic stiffness of assembly, in MN/m;	7.2.4
F_{LFA1}	minimum force applied in measurement of dynamic low frequency stiffness of assembly, in kN;	7.2.4
F_{LFA2}	maximum force applied in measurement of dynamic low frequency stiffness of assembly = 0,8 F_{LFAmax}, in kN;	7.2.4
F_{LFAmax}	reference force for measurement of dynamic low frequency stiffness of assembly, in kN;	7.2.4
d_{LFA1}	displacement of assembly in measurement of dynamic low frequency stiffness of assembly for force F_{LFA1}, in mm;	7.2.4
d_{LFA2}	displacement of assembly in measurement of dynamic low frequency stiffness of assembly for force F_{LFA2}, in mm;	7.2.4
F_{HFAmax}	static preload applied in measurement of high frequency stiffness of assembly, in kN;	B.4.3
a_{HFAD1}	excitation acceleration in measurement of high frequency stiffness of assembly, in m/s^2;	B.4.3
a_{HFAD2}	acceleration of the measuring platform in measurement of high frequency stiffness of assembly, in m/s^2;	B.4.3
F_{HFAD2}	force on the measuring platform in measurement of high frequency stiffness of assembly, in N;	B.4.3
f_{HFAD}	frequency in measurement of high frequency stiffness of assembly, in Hz;	B.4.3
j	$\sqrt{-1}$	B.4.3
L_{HFADk}	transfer stiffness level in measurement of high frequency stiffness of assembly, in dB re 1 N/m;	B.4.3

m_{HFAD}	mass of the measuring platform and any parts of the fastening assembly below the resilient element, in kg;	B.4.3
k_{HFAD}	transfer stiffness in measurement of high frequency stiffness of assembly, in N/m;	B.4.3
k_{HFADc}	corrected transfer stiffness in measurement of high frequency stiffness of assembly, in N/m;	B.4.3
v_{HFAD1}	excitation velocity = $\frac{a_{\mathrm{HFAD1}}}{j\varpi_{\mathrm{HFAD}}}$, in m/s;	B.4.3
ω_{HFAD}	angular frequency = $2\pi f_{\mathrm{HFAD}}$, in rad/s;	B.4.3
F_{HFAI2}	force on the measuring platform of high frequency stiffness of assembly, in N;	B.4.4
f_{HFAI}	frequency in measurement of high frequency stiffness of assembly, in Hz;	B.4.4
L_{HFAI}	transfer stiffness level in measurement of high frequency stiffness of assembly by the indirect method, in dB re 1 N/m;	B.4.4
m_{HFAI}	mass of the measuring platform and any parts of the fastening assembly below the resilient element, in kg;	B.4.4
k_{HFAI}	transfer stiffness in measurement of high frequency stiffness of assembly by the indirect method, in N/m;	B.4.4
ω_{HFAI}	angular frequency = $2\pi f_{\mathrm{HFAI}}$, in rad/s;	B.4.4
v_{HFAI1}	excitation velocity = $\frac{a_{HFAI1}}{j\varpi_{HFAI}}$, in m/s;	B.4.4
a_{HFAI1}	excitation acceleration in measurement of high frequency stiffness of assembly by the indirect method, in m/s^2;	B.4.4
a_{HFAP1}	excitation acceleration in measurement of high frequency stiffness of assembly by driving point method, in m/s^2;	B.4.5
a_{HFAPc}	corrected acceleration of the measuring platform in measurement of high frequency stiffness of assembly by driving point method, in m/s^2;	B.4.5
F_{HFAP1}	dynamic input force in measurement of high frequency stiffness of assembly by driving point method, in N;	B.4.5
F_{HFAPc}	dynamic input force without the rail fastening assembly in measurement of high frequency stiffness of assembly by point method, in N;	B.4.5
f_{HFAP}	frequency in measurement of high frequency stiffness of assembly by point method, in Hz;	B.4.5
L_{HFAPk}	point stiffness level, in dB re 1 N/m;	B.4.5
k_{HFAPc}	corrected point stiffness, in N/m;	B.4.5

5 Verification of calibration

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

The calibration of displacement measuring instruments shall be in accordance with EN ISO 9513.

6 Test procedures for pads

6.1 Static test procedure for pads

6.1.1 Principle

A force is applied normal to the test pad and the displacement is measured.

6.1.2 Apparatus

6.1.2.1 Controlled temperature test area:

The area of the laboratory where the test is conducted, maintained at (23 ± 5) °C.

Where pads are to be used at other ambient temperatures additional tests shall be performed, if required by the purchaser, at one or more of the following temperatures:

(−20 ± 3) °C, (−10 ± 3) °C, (0 ± 3) °C and (50 ± 3) °C.

The additional test temperatures shall be agreed between the manufacturer and the purchaser.

6.1.2.2 Metal plate:

A rigid metal plate at least as wide as the foot of the rail used for repeated loading according to EN 13146-4 and length at least 210 mm.

6.1.2.3 Load distribution plates:

A rectangular upper load distribution plate made from metal 10 mm minimum thickness, with smooth, rounded edges. The dimensions of the plate depend on the type of pad being tested as follows:

— for rail pads, the same width as the foot of the rail used for the repeated loading test (EN 13146-4) and a length of 210 mm;

— for baseplate pads, the same width and length as the maximum rectangular area within the part of the baseplate transmitting the load to the pad in the fastening assembly.

When the pad is supported in use over a limited area a lower load distribution plate, equal in dimensions to the support area, is also required.

NOTE For tests on continuous pads used in slab track a length of pad of 150 mm is used.

6.1.2.4 Abrasive cloth:

Sheets of abrasive cloth P180 to P400 in unworn condition. Each sheet being not less than the full area of the pad to be tested.

6.1.2.5 Actuator:

Actuator capable of applying a force of (F_{SPmax} + 10 %) kN.

NOTE Typically the maximum force is 120 kN.

6.1.2.6 Displacement measuring instruments:

6.1.2.6.1 Calibration procedure:

If contacting displacement measuring instruments are used they shall conform to EN ISO 9513:2012, Table 2, Class 2.

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 5.4.2.

6.1.2.6.2 Calibration requirement:

The instrument shall be capable of measuring displacements as follows:

— for pads with a declared stiffness ≤ 100 MN/m, displacement measurement within ± 0,02 mm;

— for pads with a declared stiffness > 100 MN/m, displacement measurement within ± 0,01 mm.

6.1.2.7 Force measuring instruments:

Instruments conforming to EN ISO 7500-1:2015, Class 1 over the required range of force.

6.1.2.8 Recording equipment:

Equipment to make a digital recording and print out of the displacement and applied force.

6.1.3 Procedure

All components and equipment used shall be kept in a temperature of (23 ± 5) °C or other test temperature (see 6.1.2.1) for at least 16 h prior to starting the test. Place the test set-up on a flat, rigid, horizontal base, which will support the whole area of the pad, in the following sequence: base, lower load distribution plate (if necessary), abrasive cloth (abrasive side up), pad, abrasive cloth (abrasive side down), upper load distribution plate, metal plate as shown in Figure 1.

Ensure the load distribution plates are located on the active area of the pad. Locate at least three independent instruments to measure the displacement of the metal plate at equal intervals around the perimeter of the plate.

Apply a force, F_{SPmax}, through a spherical seating in the actuator as specified in the performance requirements for the type of track for which the pad is intended.

NOTE Performance requirements are set out in other standards including the EN 13481 series.

Then reduce the force to the notional fastening assembly clip force (F_{SP1}) and repeat this cycle of loading and unloading twice more with a rate of force application (120 ± 10) kN/min. Maintain the applied force F_{SP1}, then record the displacement whilst increasing the applied force to F_{SP2}, which is 0,8 F_{SPmax} kN.

If the displacement measured by any of the instruments differs from the average displacement by ≥ 20 % of the maximum displacement, repeat the loading cycle ensuring that the force is applied centrally to the pad. Calculate the static stiffness from Formula (1) where d_{SP} is the average displacement when the applied force is increased from F_{SP1} kN to F_{SP2} kN:

$$k_{SP} = \frac{F_{SP2} - F_{SP1}}{d_{SP}} \text{ MN/m} \qquad (1)$$