**SLOVENSKI STANDARD**
**SIST EN 13146-9:2011+A1:2012**

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



**Ta slovenski standard je istoveten z: EN 13146-9:2009+A1:2011**

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**ICS:**

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|---|---|---|
| 93.100 | Gradnja železnic | Construction of railways |

**SIST EN 13146-9:2011+A1:2012 en,fr,de**

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# EN 13146-9:2009+A1

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English Version

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

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

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

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## Foreword

This document (EN 13146-9:2009+A1:2011) has been prepared by Technical Committee CEN/TC 256 “Railway applications”, the secretariat of which is held by DIN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by April 2012, and conflicting national standards shall be withdrawn at the latest by April 2012.

This document includes Amendment 1, approved by CEN on 2011-09-06.

This document supersedes EN 13146-9:2009.

The start and finish of text introduced or altered by amendment is indicated in the text by tags !A1! !A1!.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

This European Standard is one of the series EN 13146, *Railway applications — Track — Test methods for fastening systems* as listed below:



— *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*

These support the requirements in the series EN 13481, *Railway applications — Track — Performance requirements for fastening systems* — Parts 1 to 8.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

# Introduction

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

For measurements at high frequency, the corrected driving point method has been included although it is only valid up to 120 Hz whilst the direct and indirect methods are valid up to 400 Hz. Only a few test laboratories have the equipment and the experience necessary to perform the indirect and direct methods. More laboratories should be able to perform the corrected driving point method and for some purposes, measurements up to 120 Hz are adequate.

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 can be used.

# 1 Scope

This European Standard specifies laboratory test procedures to determine the static and dynamic stiffness of rail pads, baseplate pads and complete rail fastening assemblies. The procedures for dynamic stiffness cover low and high frequencies.

# 2 Normative references

The following documents are indispensable for the application 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 (all parts), *Railway applications — Track — Performance requirements for fastening systems*

EN ISO 7500-1, *Metallic materials — Verification of static uniaxial testing machines — Part 1: Tension/compression testing machines — Verification and calibration of the force-measuring system (ISO 7500-1:2004)*

EN ISO 9513:2002, *Metallic materials — Calibration of extensometers used in uniaxial testing (ISO 9513:1999)*



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)*



EN ISO 10846-2, *Acoustics and vibration — Laboratory measurement of vibro-acoustic transfer properties of resilient elements — Part 2: Direct method for determination of the dynamic stiffness of resilient supports for translatory motion (ISO 10846-2:2008)*

EN ISO 10846-3, *Acoustics and vibration — Laboratory measurement of vibro-acoustic transfer properties of resilient elements — Part 3: Indirect method for determination of the dynamic stiffness of resilient supports for translatory motion (ISO 10846-3:2002)*

EN ISO 10846-5, *Acoustics and vibration — Laboratory measurement of vibro-acoustic transfer properties of resilient elements — Part 5: Driving point method for determination of the low-frequency transfer stiffness of resilient supports for translatory motion (ISO 10846-5:2008)*

# 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.

## 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; | 6.2.4 |
| $F_{LFP1}$ | 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 A1⟩ 0,8$F_{SAmax}$ ⟨A1, 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; | 7.3.4.3 |
| $a_{HFAD1}$ | excitation acceleration in measurement of high frequency stiffness of assembly, in $m/s^2$; | 7.3.4.3 |
| $a_{HFAD2}$ | acceleration of the measuring platform in measurement of high frequency stiffness of assembly, in $m/s^2$; | 7.3.4.3 |
| $a_{HFAI2}$ | output acceleration in measurement of high frequency stiffness of assembly by the indirect method, in $m/s^2$; | 7.3.4.4 |
| $F_{HFAD2}$ | force on the measuring platform in measurement of high frequency stiffness of assembly, in N; | 7.3.4.3 |
| $f_{HFAD}$ | frequency in measurement of high frequency stiffness of assembly, in Hz; | 7.3.4.3 |
| $j$ | $\sqrt{-1}$ | 7.3.4.3 |
| $L_{HFADk}$ | transfer stiffness level in measurement of high frequency stiffness of assembly, in dB re 1 N/m; | 7.3.4.3 |
| $m_{HFAD}$ | mass of the measuring platform and any parts of the fastening assembly below the resilient element, in kg; | 7.3.4.3 |
| $k_{HFAD}$ | transfer stiffness in measurement of high frequency stiffness of assembly, in N/m; | 7.3.4.3 |
| $k_{HFADc}$ | corrected transfer stiffness in measurement of high frequency stiffness of assembly, in N/m; | 7.3.4.3 |
| $v_{HFAD1}$ | excitation velocity = $\frac{a_{HFAD1}}{j\varpi_{HFAD}}$, in m/s; | 7.3.4.3 |
| $\omega_{HFAD}$ | angular frequency = $2\pi f_{HFAD}$, in rad/s; | 7.3.4.3 |
| $F_{HFAI2}$ | force on the measuring platform of high frequency stiffness of assembly, in N; | 7.3.4.4 |
| $k_{HFAI}$ | transfer stiffness in measurement of high frequency stiffness of assembly by the indirect method, in N/m; | 7.3.4.4 |
| $\omega_{HFAI}$ | angular frequency = $2\pi f_{HFAI}$, in rad/s; | 7.3.4.4 |
| $a_{HFAI1}$ | excitation acceleration in measurement of high frequency stiffness of assembly by the indirect method, in $m/s^2$; | 7.3.4.4 |

| | | |
|---|---|---|
| $a_{HFAP1}$ | excitation acceleration in measurement of high frequency stiffness of assembly by driving point method, in m/s$^2$; | 7.3.4.5 |
| $a_{HFAPc}$ | correction acceleration of the measuring platform in measurement of high frequency stiffness of assembly by driving point method, in m/s$^2$; | 7.3.4.5 |
| $F_{HFAP1}$ | dynamic input force in measurement of high frequency stiffness of assembly by driving point method, in N; | 7.3.4.5 |
| $F_{HFAPc}$ | dynamic input force without the rail fastening assembly in measurement of high frequency stiffness of assembly by point method, in N; | 7.3.4.5 |
| $L_{HFAPk}$ | point stiffness level, in dB re 1 N/m; | 7.3.4.5 |
| $k_{HFAPc}$ | corrected point stiffness, in N/m. | 7.3.4.5 |

## 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 with contact 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

Contact instruments complying with EN ISO 9513:2002, Table 2, Class 2. When non-contact instruments are used they shall be calibrated to ensure the accuracy of measurement complies with the following requirements.



The instruments shall be capable of measuring the vertical displacement of the surface of the test pad 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 complying with EN ISO 7500-1, 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.