BS EN 13481-5:2022

BSI Standards Publication

Railway applications — Track — Performance requirements for fastening systems

Part 5: Fastening systems for ballastless tracks

bsi.

National foreword

This British Standard is the UK implementation of EN 13481-5:2022. It supersedes BS EN 13481-5:2012+A1:2017, which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee RAE/2, Railway Applications - Track.

A list of organizations represented on this committee can be obtained on request to its committee manager.

Contractual and legal considerations

Published by BSI Standards Limited 2022

ISBN 978 0 539 12954 0

ICS 93.100

Compliance with a British Standard cannot confer immunity from legal obligations.

This British Standard was published under the authority of the Standards Policy and Strategy Committee on 31 August 2022.

Amendments/corrigenda issued since publication

Date	Text affected

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 13481-5

July 2022

ICS 93.100

Supersedes EN 13481-5:2012+A1:2017

English Version

Railway applications - Track - Performance requirements for fastening systems - Part 5: Fastening systems for ballastless tracks

Applications ferroviaires - Voie - Exigences de performance pour les systèmes de fixation - Partie 5 : Systèmes de fixations pour voies sans ballast

Bahnanwendungen - Oberbau - Leistungsanforderungen für Schienenbefestigungssysteme - Teil 5: Befestigungssysteme für feste Fahrbahn

This European Standard was approved by CEN on 8 May 2022.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN-CENELEC Management Centre or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.

CEN members are the national standards bodies of 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, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and United Kingdom.

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

CEN-CENELEC Management Centre: Rue de la Science 23, B-1040 Brussels

Contents

Page

European foreword ... 3
Introduction ... 5
1 Scope ... 6
2 Normative references ... 6
3 Terms and definitions ... 7
4 Symbols ... 9
5 Requirements determined by laboratory testing ... 9
5.1 Specimens used for laboratory testing ... 9
5.2 Longitudinal rail restraint or longitudinal stiffness ... 10
5.2.1 General case ... 10
5.2.2 Special case for long structures ... 10
5.3 Clamping force and uplift stiffness ... 10
5.4 Vertical stiffness ... 11
5.5 Effect of repeated loading ... 11
5.6 Electrical resistance of the fastening system and slab track elements ... 12
5.7 Effect of exposure to severe environmental conditions (surface mounted rails only) ... 13
5.8 Anchoring fastening components ... 13
5.8.1 Cast-in or glued-in components in concrete supporting elements ... 13
5.8.2 Anchoring components on steel supporting elements ... 13
6 Other requirements ... 13
6.1 Dimensions ... 13
6.2 Effect of fastening system tolerances on track gauge ... 14
6.3 In-service testing ... 15
6.4 Attenuation of noise and vibration ... 15
7 Fitness for purpose ... 16
8 Marking, labelling and packaging ... 16
Annex A (informative) Vibration and noise ... 17
A.1 General ... 17
A.2 Symbols ... 17
A.3 Parameters for environmental vibration calculations ... 17
A.4 Calculating the vibration attenuation ... 18
A.5 Environmental noise ... 18
Bibliography ... 19

European foreword

This document (EN 13481-5:2022) 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 January 2023, and conflicting national standards shall be withdrawn at the latest by January 2023.

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

This document supersedes EN 13481-5:2012+A1:2017.

The main changes compared to the previous edition are as follows:

a) changes to the terminology to be consistent with the EN 16432 series of standards;

b) inclusion of details of in-service testing, replacing the reference to EN 13146-8, which is to be withdrawn;

c) slight reduction of test loads in repeated loading test for fastening category D;

d) editorial changes to make clear which requirements are based on laboratory testing;

e) removal of Annex ZA.

This European Standard is one of the series EN 13481 "*Railway applications — Track — Performance requirements for fastening systems*", which consists of the following parts:

— *Part 1: Definitions*

— *Part 2: Fastening systems for concrete sleepers in ballast*

— *Part 3: Fastening systems for wood and polymeric composite sleepers*

— *Part 4: Fastening systems for steel sleepers*

— *Part 5: Fastening systems for ballastless tracks*

— *Part 7: Fastening systems for switches and crossings, check rails, insulated rail joints and rail expansion devices*

NOTE Part 6 does not exist in this series.

These European Standards are supported by the test methods in the series EN 13146 "*Railway applications — Track — Test methods for fastening systems*".

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

Any feedback and questions on this document should be directed to the users' national standards body. A complete listing of these bodies can be found on the CEN website.

According to the CEN-CENELEC Internal Regulations, the national standards organisations 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, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

Introduction

A series of tests is used to assess the suitability of fastening systems for use in railway track, i.e. for type approval of complete fastening systems. This document only sets requirements considered relevant to ensure the safe, long-term operation of the track system. The test methods are described in other associated standards.

The various Categories of rail fastenings used in this document are defined in EN 13481-1:2012.

1 Scope

This document is applicable to fastening systems, in Categories A – D as specified in EN 13481-1:2012, 3.1 for attaching rails to the uppermost surface of concrete or steel elements in ballastless tracks, including tracks on open deck bridges, and for embedded rails in ballastless tracks, for maximum axle loads and minimum curve radii in accordance with Table 1.

Table 1 — Fastening category criteria

Category	Maximum design axle load kN	Minimum curve radius m
A	130	40
B	180	80
C	260	150
D	260	400
NOTE The maximum axle load for Categories A and B does not apply to maintenance vehicles.		

The requirements apply to:

— fastening systems which act on the foot and/or web of the rail including direct fastening systems and indirect fastening systems;

— fastening systems for rail sections included in EN 13674-1 (excluding 49E4), or EN 13674-4.

This document is not applicable to fastening systems for wood or polymer composite sleepers used in ballastless track, which are included in EN 13481-3.

This document is not applicable to rigid fastening systems, special fastening systems used at bolted joints or glued joints or special low clamping force fastenings used to mitigate track-bridge interaction effects.

This document is for type approval of complete fastening systems. In track forms in which there are rail seat blocks or sleepers mounted in “boots” (under-sleeper pads) the concrete element and its resilient support are considered to be parts of the elastic fastening system. If the track form includes floating slabs, (i.e. resiliently supported concrete elements with more than one fastening per rail) those concrete elements and their resilient supports are considered to be parts of the ballastless track and not of the fastening system.

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 13146-1:2019, *Railway applications — Track — Test methods for fastening systems — Part 1: Determination of longitudinal rail restraint*

EN 13146-4:2020, *Railway applications — Track — Test methods for fastening systems — Part 4: Effect of repeated loading*

EN 13146-5:2012[1], *Railway applications — Track — Test methods for fastening systems — Part 5: Determination of electrical resistance*

EN 13146-6:2012, *Railway applications — Track — Test methods for fastening systems — Part 6: Effect of severe environmental conditions*

EN 13146-7:2019, *Railway applications — Track — Test methods for fastening systems — Part 7: Determination of clamping force and uplift stiffness*

EN 13146-9:2020, *Railway applications — Track — Test methods for fastening systems — Part 9: Determination of stiffness*

EN 13146-10:2017, *Railway applications — Track — Test methods for fastening systems — Part 10: Proof load test for pull-out resistance*

EN 13230-1:2016, *Railway applications — Track — Concrete sleepers and bearers — Part 1: General requirements*

EN 13481-1:2012, *Railway applications — Track — Performance requirements for fastening systems — Part 1: Definitions*

EN 13674-1:2011+A1:2017, *Railway applications — Track — Rail — Part 1: Vignole railway rails 46 kg/m and above*

EN 13674-4:2019, *Railway applications — Track — Rail — Part 4: Vignole railway rails from 27 kg/m to, but excluding 46 kg/m*

EN 17319:2020, *Railway applications — Infrastructure — Performance requirements of rail fastening systems for tramways*

EN 17343:2020, *Railway applications — General terms and definitions*

3 Terms and definitions

For the purposes of this document, the following terms and definitions given in EN 13481-1:2012, EN 17343:2020 and the following apply.

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

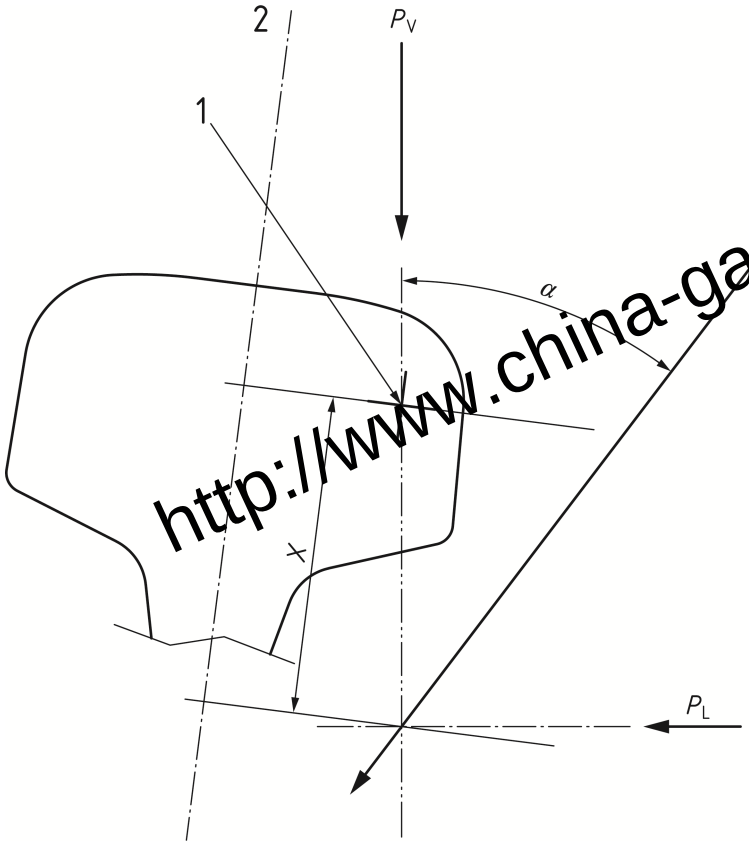
— IEC Electropedia: available at https://www.electropedia.org/

— ISO Online browsing platform: available at https://www.iso.org/obp

3.1
datum for applied test loads
flat bottom surface of a conventional concrete sleeper used as a datum plane to define the orientation of the applied test loads

Note 1 to entry: For fastenings on supports which do not have a flat bottom surface, the orientation of the test loads is defined relative to “running surface of the rails” which is defined in EN 13848-1:2019. See Figure 1.

[1] As impacted by EN 13146-5:2012/AC:2017.



Key

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

Figure 1 — Load application position

3.2
purchaser
operator, owner or user of the rail fastening system

3.3
supplier
body responsible for the use of this European Standard

Note 1 to entry: Sometimes the manufacturer is also the supplier.

4 Symbols

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

D_r maximum longitudinal displacement of rail prior to slip, in mm;

F_{LFA1} minimum force applied in measurement of low frequency dynamic stiffness of assembly, in kN;

F_{LFAmax} reference force for measurement of low frequency dynamic stiffness of assembly, in kN;

F_{LFP1} notional fastening clip force assumed for measurement of low frequency dynamic stiffness of pad, in kN;

F_{LFPmax} reference force for measurement of low frequency dynamic stiffness of pad, in kN;

F_{max} axial load at which gross slip occurs in the longitudinal rail restraint test in kN;

F_{SA1} minimum force applied in measurement of static stiffness of assembly, in kN;

F_{SAmax} force applied to assembly in measurement of static stiffness of assembly, in kN;

F_{SP1} notional fastening clip force assumed for measurement of static stiffness of pad, in kN;

F_{SPmax} force applied to pad in measurement of static stiffness of pad, in kN;

k_L longitudinal stiffness in accordance with EN 13146-1:2019, in MN/m;

k_{LFA} low frequency dynamic stiffness of assembly, in MN/m;

L_T sample length of embedded rail, in m;

P_L component of load parallel to the datum, in kN;

P_V component of load normal to the datum, in kN;

X distance between the line of application of P_L and the centre of the gauge corner radius of the rail head as shown in Figure 1, in mm;

α angle between the load line and the datum as shown in Figure 1, in °.

5 Requirements determined by laboratory testing

5.1 Specimens used for laboratory testing

The laboratory tests described in 5.2 to 5.5 and 5.7 shall be carried out using a supporting element e.g. a reinforced concrete block to represent concrete ballastless track or a steel plate to represent a steel bridge structure.

For continuously supported rail, the test length of rail is the length which is supported on the pad. For embedded rail, the test length of rail is the length which is embedded. In these cases, for category A the test length should be (0,8 ± 0,01) m and for categories B to D the test length should be (0,6 ± 0,01) m.

The supporting element shall have a rail seat inclination no greater than the inclination to be used on the application for which the type of fastening will be used.

For example, a fastening tested successfully on a support with 1:40 inclination does not need to be re-tested at 1:20 inclination.

For the laboratory test described in 5.6 two fastenings shall be assembled on a section of concrete track or steel structure with a length equivalent to the intended fastener spacing as described in EN 13146-5:2012[1].

For the laboratory test described in 5.8 a fastening system shall be assembled on a concrete block or steel element as described in EN 13146-10:2017.

5.2 Longitudinal rail restraint or longitudinal stiffness

5.2.1 General case

The requirement for longitudinal rail restraint is included to control rail creep and pull apart in the event of a broken rail.

For discrete fastening systems, and for continuously supported rail with mechanical fastening, the longitudinal rail restraint shall be not less than 7,0 kN when measured by the procedure in EN 13146-1:2019 before any repeated load test is carried out. For fastenings to be used in lines with trains operating at speeds above 250 km/h, the longitudinal rail restraint shall be not less than 9,0 kN when measured by the procedure in EN 13146-1:2019 before any repeated load test is carried out.

For embedded rail with an adhesive fastening system, the longitudinal stiffness k_L shall be measured in accordance with EN 13146-1:2019, between 0 mm and D_r relative displacement per equivalent length of support without visible damage. The value of D_r should be agreed between the purchaser and the supplier. In the absence of any such agreement, a value of D_r = 7 mm shall be used. The longitudinal rail restraint shall be not less than 7,0 kN.

5.2.2 Special case for long structures

On structures such as long bridges, the longitudinal force transmitted between the track and the structure may be calculated by the method described in CEN/TR 17231:2018 and used in EN 1991-2:2003[2]. The value of F_{max} measured in accordance with EN 13146-1:2019 may be used in the calculation. In such cases and subject to agreement between the purchaser and manufacturer, the minimum requirement for longitudinal rail restraint may be reduced.

5.3 Clamping force and uplift stiffness

This shall be determined by the procedure in EN 13146-7:2019. The result shall be reported.

If the rail fastening system is to be used on long bridge structures calculations of track-bridge interaction effects at bridge deck ends, such as those required in EN 1991-2:2003[2], may require values of uplift stiffness of the fastening system. If such information is required it shall be determined using the method set out in EN 13146-7:2019.

This requirement for clamping force is not applicable to web support fastening systems.

If required by the purchaser, the uplift restraint and uplift stiffness of embedded rail systems shall be determined using the methods set out in EN 17319:2020 Annexes B and C, respectively.

---

2 As impacted by EN 1991-2:2003/AC:2010.

5.4 Vertical stiffness

The assembly stiffness shall be measured to inform the purchaser of an important mechanical property of the fastening system and to determine the parameters for the repeated loading test (see 6.5). The assembly static stiffness and assembly low frequency dynamic stiffness at 5 Hz shall be measured in accordance with EN 13146-9:2020.

Stiffness testing of pads is not a requirement for type approval of the fastening but may be used to provide guidance for other tests, e.g. quality control. If required, pads shall be tested in accordance with EN 13146-9:2020.

Loads are given in Table 2 for testing pads and for testing complete fastening assemblies. For embedded rail, these test loads apply to a specimen as described in 5.1. In the case of a shorter specimen being used, the test load shall be reduced proportionally.

Table 2 — Loads for measurement of stiffness

Fastening category	F_{SP1} and F_{LFP}	F_{SPmax} and F_{LFPmax}	F_{SA1} and F_{LFA1}	F_{SAmax} and F_{LFAmax}
	kN	kN	kN	kN
A	16	51	1	32
B	18	64	1	43
C	18	85	1	64
D	18	85	1	64

NOTE Guidance on the measurement of pad high frequency dynamic stiffness is given in EN 17495:—[3]. For the measurement of assembly properties at acoustic frequencies see EN 15461 and EN 17495:—[3].

5.5 Effect of repeated loading

The effect of repeated loading shall be determined by the procedure in EN 13146-4:2020. In the case of twin block, booted concrete sleepers, the whole sleeper shall be subject to testing using the procedure for two rail seats.

The test loads and positions shall be as shown in Table 3. Background information and a general justification for the test load conditions may be found in CEN/TR 17320:2019.

For embedded rail, these test loads apply to a specimen with the rail embedded for 0,8 m in Category A, and 0,6 m in other Categories. In case of a shorter specimen, the test load shall be reduced proportionally.

[3] Under preparation. Stage at the time of publication: FprEN 17495:2022.

Table 3 — Test loads and positions

k_{LFA}	< 40 MN/m			≥ 40 < 75 MN/m			≥ 75 < 100 MN/m			≥ 100 MN/m		
Category	**α** °	**X**[a] mm	**P_v/cos α** kN	**α** °	**X**[a] mm	**P_v/cos α** kN	**α** °	**X**[a] mm	**P_v/cos α** kN	**α** °	**X**[a] mm	**P_v/cos α** kN
A	45	100	50	45	100	55	38,6	50	65	38,6	50	80
B	38,6	100	55	38,6	100	60	38,6	75	70	38,6	50	85
C	33	25	60	33	25	65	33	25	75	33	25	95
D	26	15	56	26	15	61	26	15	70	26	15	89

[a] For embedded rail and web supported rail, the rail section shall be unmodified (i.e. X = 0).

As required by EN 13146-4:2020, the following measurements shall be performed before and after repeated loading. The change in performance (increase or decrease) shall not exceed the values shown below.

— Change in longitudinal rail restraint or longitudinal stiffness ≤ ± 20 %;

— change in vertical static stiffness ≤ ± 25 %;

— change in clamping force ≤ ± 20 %.

The requirement for change in vertical static stiffness is not applicable to fastening systems with static stiffness ≥ 300 MN/m.

The requirement for change in clamping force is not applicable to fastening systems which support the web of the rail or for fastening systems for embedded rail.

Any visible fracture of the components of the test specimen shall be reported in accordance with EN 13146-4:2020.

Compliance with Category C implies compliance with Categories C and D.

5.6 Electrical resistance of the fastening system and slab track elements

If the purchaser requires the fastening system to provide electrical insulation, this shall be not less than 5 kΩ when measured in accordance with EN 13146-5:2012[1]. The purchaser may specify a higher value for use with certain track circuits.

When testing surface mounted systems with discrete supports, two fastening assemblies, one for each rail, are mounted on a section of the slab track of length, parallel to the rail, at least sufficient to fully support the rail pads. It shall also include the encasement of any concrete element forming part of the fastening system as described in 5.1 and reinforcement similar to that used in track in the concrete elements.

For surface mounted fastening systems incorporating continuous support of the rails, and for embedded rail fastening systems, the test specimen shall be representative of the slab on which the rails are supported.

— For mechanical fastening systems for surface mounted rail, the length of the specimen shall be the nominal sleeper spacing in EN 13481-1:2012, 3.1.

— For embedded rail systems, the embedded length of the specimen shall be 0,6 ± 0,01 m except when testing to Category A in which case the embedded length of the specimen shall be 0,8 ± 0,01 m.

NOTE This requirement relates to signalling currents only, not to traction currents. Guidance on traction currents is given in EN 50122-2.

5.7 Effect of exposure to severe environmental conditions (surface mounted rails only)

The effect of exposure to severe environmental conditions shall be determined in accordance with EN 13146-6:2012. Following exposure to the salt spray test, the fastening assembly shall be capable of being dismantled, without failure of any component, and re-assembled using manual tools provided for this purpose.

5.8 Anchoring fastening components

5.8.1 Cast-in or glued-in components in concrete supporting elements

Components of the fastening assembly may be cast into the concrete during manufacture of concrete elements or construction of the slab, or glued into the concrete elements or slab after the concrete has hardened. These components shall be subject to a vertical load test using the procedure described in EN 13146-10:2017.

Three concrete blocks, each incorporating cast-in or glued-in components for one fastening assembly, shall be selected for this test. One cast-in or glued-in component in each block shall be tested.

The proof load to be applied may be specified by the designer of the ballastless track system. If no such requirement is specified the proof load applied in each test shall be 60 kN if there are two cast-in or glued-in components per rail seat, 40 kN if there are three cast-in or glued-in components per rail seat and 30 kN if there are four or more cast-in or glued-in components per rail seat.

After the test there shall be no evidence of damage to the fastening component or supporting element that could result in a loss of integrity or durability of the fastening system. Localized spalling of the concrete surface immediately adjacent to the fastening insert is not to be considered to be a reason to reject the system.

5.8.2 Anchoring components on steel supporting elements

Components which are bolted or welded onto steel supporting elements shall be subject to a vertical load test using the procedure described in EN 13146-10:2017.

Three anchors shall be tested, each attached to a steel supporting element.

The proof load to be applied may be specified by the designer of the ballastless track system. If no such requirement is specified the proof load applied in each test shall be 60 kN if there are two anchoring components per rail seat, 40 kN if there are three anchoring components per rail seat and 30 kN if there are four or more anchoring components per rail seat.

After the test there shall be no evidence of damage to the fastening component or supporting element that could result in a loss of integrity or durability of the fastening system.

6 Other requirements

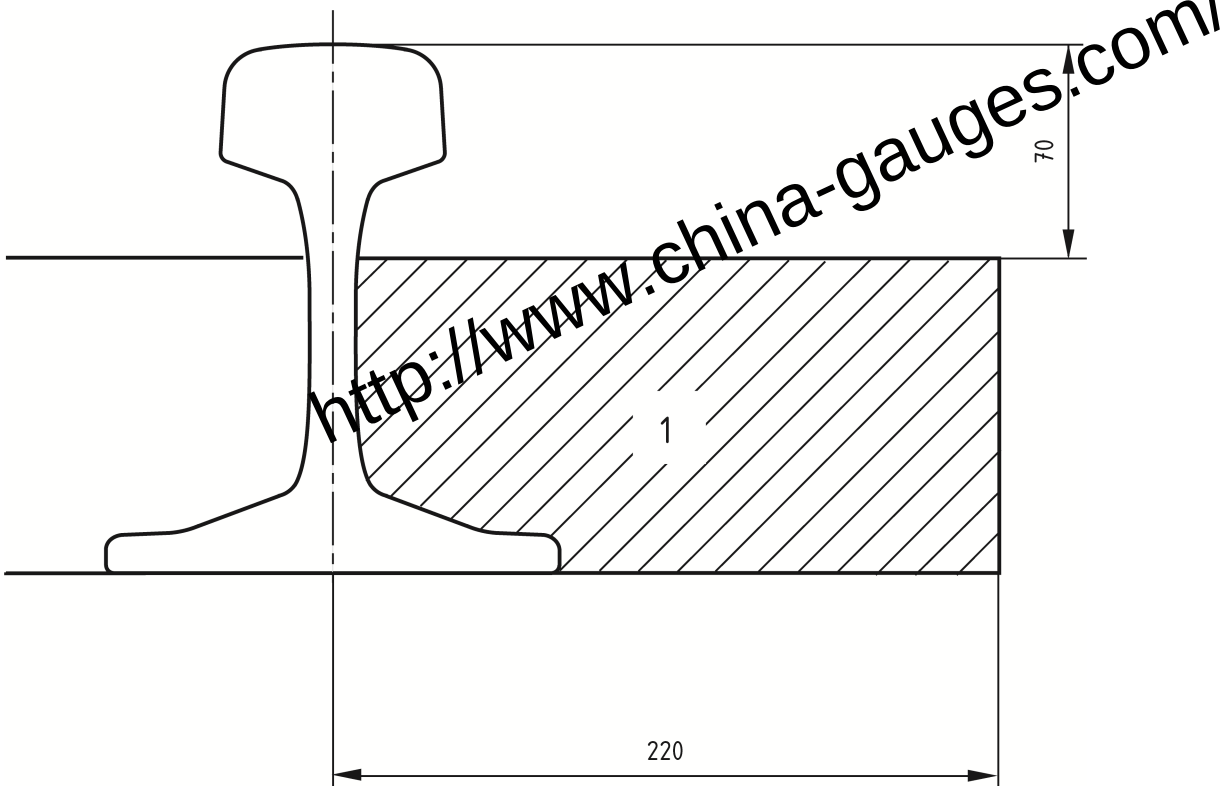
6.1 Dimensions

The overall dimensions shall be within the envelope shown in Figure 2 to avoid interference with vehicles including track maintenance vehicles.

This requirement does not apply to embedded rail or web support fastening systems. For such fastening systems, the minimum flangeway should comply with national regulations and the envelope for the fastening systems shall be provided by the supplier. This is applicable to all rail sections in EN 13674-1 and EN 13674-4, excluding 49E4.

Where an outside conductor rail is used, the width of the envelope is reduced from 220 mm to 180 mm.

Dimensions in mm



Key

1 envelope for rail fastening

NOTE The envelope is symmetrical about rail centre line.

Figure 2 — Envelope for rail fastening

6.2 Effect of fastening system tolerances on track gauge

Calculations shall be provided by the manufacturer to show the maximum variation in static track gauge which can arise from the fastening system. The calculations shall be based on the design dimensions of the rail section given in EN 13674-1:2011+A1:2017 or EN 13674-4:2019 and shall include any assumption about the position of the rail within the fastening assembly and the tolerances on all components of the fastening system. It shall not include tolerances arising from the location of the fastening components in the slab or from any baseplate location. The variation in track gauge, calculated in this way, shall not exceed ± 1 mm.

The supplier shall also provide a drawing of the interface between the fastening system and the element of slab track. This drawing shall include:

— the external gauge point (see EN 13230-1:2016, Figure 2) of the rail fastening system which is the reference point for the track gauge (for example holes or elements cast into slabs);

— the dimension and the tolerance between internal and external gauge points for the rail section for which the fastening assembly is designed;

— drawings with dimensions and tolerances of components of the fastening system;

— the design inclination of the rail seat.

6.3 In-service testing

If required by the purchaser, in-service testing may be carried out as a part of the type approval process. All "pass/fail" criteria which are to be applied in assessing the rail fastenings at the conclusion of the test shall be agreed before the test is undertaken.

The purchaser shall state, in advance of the test

— the expected length of any test site;

— the track and traffic conditions (including train speed and axle loading, curvature, super-elevation);

— the duration of the test in terms of elapsed time from installation and/or accumulated passing tonnage.

Typical conditions for testing would be a test over 300 m with 20 MGT of passing traffic over a period of at least one year.

Parameters to be assessed may include

a) retention of track gauge;

b) permanent longitudinal movement of the rail, relative to the supporting structure;

c) effect on performance of signalling systems;

d) clamping force (measured on a sample number of fastening components removed from the track and tested using the supplier's recommended test method);

e) rail pad stiffness (measured on a sample number of pads removed from the track and in accordance with EN 13146-9:2020);

f) security of attachment to the supporting structure;

g) condition of the rail head;

h) condition of the supporting structure including rail seat area;

i) condition of individual fastening components;

j) ease of assembly and removal using the tools recommended by the supplier;

Many of the above may only be assessed by visual inspection. Where quantifiable parameters (e.g. clamping force or pad stiffness) are used for assessment the purchaser shall specify in advance the acceptable limits for the results of measurements at the end of the trial. Assessment shall not be based on the percentage change in the value over the period of the test, as it is not generally possible to establish the condition of individual components at the commencement of the test with sufficient accuracy.

6.4 Attenuation of noise and vibration

Advice on the attenuation of noise and vibration is given in Annex A.

7 Fitness for purpose

The supplier shall ensure that the fastening systems supplied comply with the requirements of this document. Specifications for individual components shall be provided by the supplier at the time the assembly is presented for testing.

NOTE Users of this European Standard are advised to consider the desirability of quality system assessment and registration against EN ISO 9001 by an accredited third party.

8 Marking, labelling and packaging

Where there is adequate space for legible marking and no effect on performance, each component shall be permanently marked with raised or indented symbols or letters which identify the manufacturer and include the particular component reference. When components are packed in containers, each container shall be labelled with details of the components and with the production batch number or date of manufacture.

Annex A
(informative)

Vibration and noise

A.1 General

The physical behaviour of the rail fastening system influences vibration transmitted into the track structure, and noise emitted from the track and the structure. Prediction models for structural and environmental vibration and noise may require input parameters which relate to this behaviour. In some situations, rail fastenings may be designed to control vibration transmission: in such cases these parameters are especially important.

This annex gives advice on the parameters and their use.

A.2 Symbols

For the purposes of this annex the following symbols and those in Clause 4 apply:

D_i	Insertion loss, in dB;
F_{HFAmax}	static preload applied in the measurement of high frequency stiffness of assembly, in kN;
k_{HFAD}	transfer stiffness in measurement of high frequency stiffness of assembly, in N/m;
j_ω	$\sqrt{-1}$;
k	transfer stiffness, in N/m;
Z_F	foundation impedance, in dB;
Z_O	source impedance, in dB.

A.3 Parameters for environmental vibration calculations

In order to predict or analyse environmental vibration and secondary noise caused by the passage of trains, it is necessary to know the stiffness of the rail fastening assembly subjected to vibration at appropriate amplitudes and frequencies. In general, it is not possible to replicate both the amplitude and the frequency in a small scale laboratory test.

Tests may be carried out with representative load amplitudes, at frequencies up to 20 Hz. When required, such tests should be carried out in accordance with EN 13146-9:2020, 7.2. The maximum load, F_{LFAmax}, is given in Table 2 and any test frequency may be specified in the range 3 Hz to 10 Hz. The result of this test is the low frequency dynamic stiffness of the fastening assembly, k_{LFA}, for the specified track category and frequency.

Tests may be carried out at higher frequencies, but only at very small amplitudes of load. When required, such tests should be carried out in accordance with EN 17495:—[3]. The pre-load F_{HFAmax} applied is 50 % of the maximum load, F_{LFAmax}, given in Table 2. The result of this test is a graph of transfer stiffness, k_{HFAD}, against frequency for the specified track category.

A.4 Calculating the vibration attenuation

The attenuation of a fastening system can be expressed in terms of the insertion loss (D_i) which describes the reduction in the level of sound power transmitted to the foundation.

For fastening systems that can be modelled by a single degree of freedom system of transfer stiffness k, the calculation, using Formula (A.1) involves the foundation impedance (Z_F) and the source impedance (Z_0).

$$D_i = 20 \lg \left| 1 + \frac{j\omega}{k} \frac{Z_F Z_0}{Z_F + Z_0} \right| \text{ dB} \quad \text{(A.1)}$$

The derivation of Z_F and Z_0 cannot be given in general terms as it depends on details of the vehicles and track. Further information is given in [5].

A.5 Environmental noise

Many models used for prediction of railway noise require input of a value for rail fastening stiffness. This value is derived from the test procedure given in EN 15461, which requires tests to be carried out on a complete panel of railway track.

Where such a panel of track is not available, and it is necessary to estimate the stiffness from tests on a single rail fastening assembly, indicative values of stiffness for noise prediction may be obtained by carrying out the test in EN 17495:—[3].

Bibliography

[1] EN 1991-2:2003[2], *Eurocode 1: Actions on structures — Part 2: Traffic loads on bridges*

[2] EN 15461, *Railway applications — Noise emission — Characterisation of the dynamic properties of track sections for pass by noise measurements*

[3] EN 50122-2, *Railway applications — Fixed installations — Electrical safety, earthing and the return circuit — Part 2: Provisions against the effects of stray currents caused by d.c. traction systems*

[4] EN ISO 9001, *Quality management systems — Requirements (ISO 9001)*

[5] Wettschurek R., Hauck G. Geräusche und Erschütterungen aus dem Schienenverkehr. In: Taschenbuch der Technischen Akustic, (Heckl M., Müller H., eds.). Springer Verlag, Berlin, Heidelberg, New York

[6] EN 16432 (series), *Railway applications — Infrastructure – Ballastless Track*

[7] EN 17495:—[3], *Railway applications — Acoustics — Determination of the dynamic stiffness of elastic track components related to noise and vibration — Rail pads and rail fastening assemblies*

[8] CEN/TR 17231:2018, *Eurocode 1: Actions on Structures — Traffic Loads on Bridges — Track-Bridge Interaction*

[9] CEN/TR 17320:2019, *Railway applications — Infrastructure — Determination of laboratory test parameters for assessing the mechanical durability of rail fastening systems — Complementary element*

[10] EN 13848-1:2019, *Railway applications — Track — Track geometry quality — Part 1: Characterization of track geometry*

British Standards Institution (BSI)

BSI is the national body responsible for preparing British Standards and other standards-related publications, information and services.

BSI is incorporated by Royal Charter. British Standards and other standardization products are published by BSI Standards Limited.

About us

We bring together business, industry, government, consumers, innovators and others to shape their combined experience and expertise into standards -based solutions.

The knowledge embodied in our standards has been carefully assembled in a dependable format and refined through our open consultation process. Organizations of all sizes and across all sectors choose standards to help them achieve their goals.

Information on standards

We can provide you with the knowledge that your organization needs to succeed. Find out more about British Standards by visiting our website at bsigroup.com/standards or contacting our Customer Services team or Knowledge Centre.

Buying standards

You can buy and download PDF versions of BSI publications, including British and adopted European and international standards, through our website at bsigroup.com/shop, where hard copies can also be purchased.

If you need international and foreign standards from other Standards Development Organizations, hard copies can be ordered from our Customer Services team.

Copyright in BSI publications

All the content in BSI publications, including British Standards, is the property of and copyrighted by BSI or some person or entity that owns copyright in the information used (such as the international standardization bodies) and has formally licensed such information to BSI for commercial publication and use.

Save for the provisions below, you may not transfer, share or disseminate any portion of the standard to any other person. You may not adapt, distribute, commercially exploit or publicly display the standard or any portion thereof in any manner whatsoever without BSI's prior written consent.

Storing and using standards

Standards purchased in soft copy format:

- A British Standard purchased in soft copy format is licensed to a sole named user for personal or internal company use only.
- The standard may be stored on more than one device provided that it is accessible by the sole named user only and that only one copy is accessed at any one time.
- A single paper copy may be printed for personal or internal company use only.

Standards purchased in hard copy format:

- A British Standard purchased in hard copy format is for personal or internal company use only.
- It may not be further reproduced – in any format – to create an additional copy. This includes scanning of the document.

If you need more than one copy of the document, or if you wish to share the document on an internal network, you can save money by choosing a subscription product (see 'Subscriptions').

Reproducing extracts

For permission to reproduce content from BSI publications contact the BSI Copyright and Licensing team.

Subscriptions

Our range of subscription services are designed to make using standards easier for you. For further information on our subscription products go to bsigroup.com/subscriptions.

With **British Standards Online (BSOL)** you'll have instant access to over 55,000 British and adopted European and international standards from your desktop. It's available 24/7 and is refreshed daily so you'll always be up to date.

You can keep in touch with standards developments and receive substantial discounts on the purchase price of standards, both in single copy and subscription format, by becoming a **BSI Subscribing Member.**

PLUS is an updating service exclusive to BSI Subscribing Members. You will automatically receive the latest hard copy of your standards when they're revised or replaced.

To find out more about becoming a BSI Subscribing Member and the benefits of membership, please visit bsigroup.com/shop.

With a **Multi-User Network Licence (MUNL)** you are able to host standards publications on your intranet. Licences can cover as few or as many users as you wish. With updates supplied as soon as they're available, you can be sure your documentation is current. For further information, email cservices@bsigroup.com.

Revisions

Our British Standards and other publications are updated by amendment or revision.

We continually improve the quality of our products and services to benefit your business. If you find an inaccuracy or ambiguity within a British Standard or other BSI publication please inform the Knowledge Centre.

Useful Contacts

Customer Services
Tel: +44 345 086 9001
Email: cservices@bsigroup.com

Subscriptions
Tel: +44 345 086 9001
Email: subscriptions@bsigroup.com

Knowledge Centre
Tel: +44 20 8996 7004
Email: knowledgecentre@bsigroup.com

Copyright & Licensing
Tel: +44 20 8996 7070
Email: copyright@bsigroup.com

BSI Group Headquarters

389 Chiswick High Road London W4 4AL UK

bsi.