SLOVENSKI STANDARD
SIST EN 15328:2020

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Železniške naprave - Zavore - Zavorne obloge

Railway applications - Braking - Brake pads

Bahnanwendungen - Bremsen - Bremsbeläge

Applications ferroviaires - Freinage - Garnitures de frein

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Contents

Page

European foreword

This document (EN 15328:2020) 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of an identical text or by endorsement, at the latest by January 2021, and conflicting national standards shall be withdrawn at the latest by January 2021.

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 has been prepared under a standardization request given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive 2016/797/EU.

For relationship with EU Directive 2016/797/EU, see informative Annex ZA, which is an integral part of this document.

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

This document gives the requirements for the design, dimensions, performance and testing of a brake pad which, as part of a disc brake system, acts on one friction face of a brake disc in accordance with EN 14535-1 and EN 14535-2.

The generic test program can also be used with different program parameter figures for specific project applications. The use of project adapted programs is subject to agreement between the parties involved.

This document contains the requirements for interfacing the brake pads with the rail vehicle, the testing procedures in order to confirm that it satisfies the basic safety and technical requirements, the material control procedures to ensure product quality, reliability and conformity, as well health and environmental requirements are fulfilled.

Each manufacturer is responsible for ensuring that the quality of design, workmanship and construction is in accordance with good engineering practice.

1 Scope

This document specifies requirements for pads for disc brakes of railway rolling stock.

The document defines requirements and generic test programs for brake pads on dynamometer. This document does not cover mandatory tests to verify stopping distances in addition to laboratory, bench test and in-service tests. In order to qualify the brake pad performance in accordance with the classification the standard provides fixed parameter figures as categories defined in paragraph classification scheme.

This document is not applicable for urban rail applications.

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 14478:2017, *Railway applications - Braking - Generic vocabulary*

EN 14535-1:2019, *Railway applications - Brake discs for railway rolling stock - Part 1: Brake discs pressed or shrunk onto the axle or drive shaft, dimensions and quality requirements*

EN 14535-2:2019, *Railway applications - Brake discs for railway rolling stock - Part 2: Brake discs mounted onto the wheel, dimensions and quality requirements*

EN 14535-3:2015, *Railway applications - Brake discs for railway rolling stock - Part 3: Brake discs, performance of the disc and the friction couple, classification*

EN 16451:2015, *Railway applications - Braking - Brake pad holder*

EN ISO 4287:1998, *Geometrical product specifications (GPS) - Surface texture: Profile method - Terms, definitions and surface texture parameters (ISO 4287:1997)*

UIC 548:2016, *Brakes - Requirements of friction test benches for the international certification of brake pads and brake blocks*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 14478:2017, EN 14535-1:2019, EN 14535-2:2019 and EN 14535-3:2015 and the following 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 https://www.iso.org/obp/ui

3.1
instantaneous coefficient of friction
instantaneous value of coefficient of friction of the friction couple brake pad/brake disc at any instant during braking

3.2
static coefficient of friction
coefficient of friction achieved by the friction couple at the point where relative movement between the brake pad friction face and brake disc friction face begins

3.3
brake disc temperature
arithmetic average value of the temperature measurements on the brake disc friction faces

3.4
contact surface area
static contact surface of the brake pad available for frictional engagement with the brake disc friction face

3.5
friction material
consumable portion of the brake pad that acts on the friction face of the brake disc in order to provide the specified brake performance

3.6
brake pad
assembly of friction material and an associated fixing element acting on one friction face of a brake disc

Note 1 to entry: A brake pad can be manufactured in one piece or comprise two separate parts. Where manufactured in two separate halves, the brake pad comprises one left-hand and one right-hand half. For a brake disc four brake pad halves or two brake pads can be used.

4 Symbols and abbreviations

For the purposes of this document, the symbols and abbreviations given in Table 1 apply.

Table 1 — Symbols and abbreviations

Symbol	Designation	Unit
F_B	Nominal application force per brake disc	kN
F_b	Instantaneous application force per brake disc	kN
m	Mass to be braked per brake disc (inclusive of the rotational masses)	t
Q	Water flow rate	l/h
R_a	Refer to EN ISO 4287	µm
R_z	Refer to EN ISO 4287	µm
s_2	Stopping distance from the moment on when F_b = 0,95 F_B to rest	m
v_0	Theoretical initial speed at the brake application initiation	km/h
v	Instantaneous speed	km/h
v_{max}	Maximum service speed	km/h
μ_a	Friction coefficient (brake pad): The instantaneous friction coefficient specified at every instant of the braking time	—
$\mu_m = \frac{1}{s_2} \cdot \int_0^{s_2} \mu_a \cdot d_s$	Mean friction coefficient: The mean friction coefficient μ_m integrated over the time from where 95 % of the nominal application force F_B is reached over the stopping distance s_2	—
$\mu_{m,nom}$	Nominal friction coefficient (brake pad)	—
θ_0	Mean initial temperature at the beginning of the brake application	°C
CI	Cast iron	
MU	Multiple unit (EMU/DMU)	
SBP	Standard brake pad	

5 Characteristics and test method of the brake pads

5.1 Classification of brake pads

This document defines the characteristics required for the categories A1 to G1 of brake pads, listed in Table 5. The characteristic requirements for the application in coaches used in general operation are listed in Table 7.

5.2 Coefficient of friction

The coefficient of friction should be independent of the wear (full thickness of the brake pad), the specific pressure, the temperature and the environmental conditions.

In wet conditions, or when there is snow, the instantaneous coefficient of friction should vary only slightly compared to the coefficient of friction under dry conditions.

These frictional characteristics shall be assessed in accordance with 5.5 to 5.6.

5.3 Environmental impact, health and safety

All raw materials used in the manufacture of the brake pads shall comply with the relevant requirements for environment, health and safety.

NOTE Relevant requirements are given in regulations of environment, health and safety, notably REACH regulations.

In addition, a safety data sheet shall be presented.

5.4 Usage requirements

The composition of the material from which the brake pads are made should be chosen so that the best compromise is obtained between:

— the frictional properties,

— the wear of the brake pads, and

— the aggressiveness against the brake disc.

5.5 Frictional requirements for brake pads

5.5.1 General

This subclause describes the requirements for brake pads used in locomotives, MUs, freight wagons and coaches. Optional test programs and requirements for coaches are defined in 5.6.

5.5.2 Priority levels of brake applications

In the test programs A1 to G1, the brake applications are prioritized, in accordance with a decreasing level of importance, as given in Table 2.

Brake applications with highest nominal application force (highest nominal deceleration) under normal conditions representing emergency brake applications are rated with priority 1. All other brake applications are rated according to their safety relevance with priorities 2 to 4. Continuous and parking brake applications are not stopping brake applications and therefore assessed according to different criteria and there is no priority level assigned with these brake applications. Bedding brake applications which are carried out prior to the main stopping brake applications are assessed separately.

Table 2 — Priority levels of brake applications for test programs

Priority level	Type of brake application
1	Dry brake applications with the highest nominal application force for each mass, normal conditions
2	Wet brake applications and hot brake applications with highest nominal application force, for each mass
3	Brake applications with highest nominal application force used for cleaning, drying, regenerating, or after continuous brake applications, for each mass
4	All other brake applications, with the exception of continuous brake applications and bedding brake applications and the examination of static coefficient of friction
—	Continuous brake applications, brake applications used for bedding-in, examination of static coefficient of friction

Normal conditions refer to brake applications under dry conditions with low initial temperature and with the brake disc and the brake pad unaffected by high thermal load or residual wetness.

Brake pads of categories A1 to G1 are characterized by their friction behaviour, expressed as the velocity-dependent nominal line.

The nominal line for the coefficient of friction is calculated for each brake pad and each test program as the linear regression line of the mean coefficients of friction (expressed in a rounding range of 0,001) versus speed of all brake applications with priority 1, extending from the lowest to the highest test speed.

5.5.3 Criteria for the nominal line

The nominal line should lie between 0,300 and 0,450.

It shall lie between 0,280 and 0,470. The difference between the maximum value and the minimum value of the nominal line shall be less or equal to 0,150.

5.5.4 Criteria for the mean coefficient of friction

Allowed deviations of coefficients of friction are expressed by means of tolerance bands centred around the nominal line.

The tolerance bands for the mean coefficients of friction in accordance with their priority level are given in Table 3.

Table 3 — Tolerance bands for the mean coefficients of friction vs. priority levels

Priority level of brake application	1	2	3	4
Tolerance band 1	±10 %	±15 %	±20 %	±25 %
Tolerance band 2	±15 %	±20 %	±25 %	±30 %

The mean coefficient of friction for each brake application shall lie within the bounds of the tolerance band 1 in accordance with its priority, while the following exceptions are tolerated.

— A total of 6 % of all brake applications (rounded to the closest integer) of priority 1 may deviate from tolerance band 1 towards the negative side.

— A total of 12 % of all brake applications (rounded to the closest integer) of priority 1 may deviate from tolerance band 1.

— A total of 5 % of all brake applications (rounded to the closest integer) of priorities 2 to 4 may deviate from tolerance band 1 towards the negative side.

— A total of 10 % of all brake applications (rounded to the closest integer) of priorities 2 to 4 may deviate from tolerance band 1.

No mean coefficient of friction shall lie outside of tolerance band 2.

5.5.5 Criteria for continuous brake applications

During continuous brake applications, after 10 s the instantaneous coefficient of friction shall stay inside the band defined by μ_{min} = 0,250 and μ_{max} = 0,500.

After 2 minutes the instantaneous coefficient of friction shall not vary more than 0,05 during any minute and the coefficient of friction shall stay inside the band defined by μ_{min} = 0,250 and μ_{max} = 0,500.

The brake pad wear during any continuous brake application, including the stop brake application thereafter, shall not exceed 1 mm. The wear in mm can be calculated from the weight differences before and after the continuous brake application.

5.5.6 Criteria for bedding brake applications

The nominal coefficient of friction of the bedded state shall be defined as the average of measured mean coefficients of friction μ_m of the last 5 braking stops carried out during the bedding section.

During the bedding-in phase, the mean coefficients of friction shall not exceed the following variations from the nominal value of the bedded state:

— ± 30 % from the 11th bedding-in brake application until 30 % of number of the bedding-in applications are finished;

— ± 15 % during the rest of the bedding-in process.

5.6 Requirements and optional test programs for brake pads for coaches

5.6.1 General

The frictional requirements for brake pads in coaches used in generic operation are described in 5.6.2 to 5.6.6. The optional test programs are defined in S1.1 and S2.1 for organic material and T1 and T2 for sintered material, and may be used instead of energy class C0 (see Annex C).

5.6.2 Tolerance ranges

The tolerance ranges for the instantaneous and mean coefficients of friction on a dry brake disc are given for the respective applications in the figures of the corresponding annexes. The instantaneous and the mean coefficients of friction measured in the test bench tests shall be documented in the appropriate tolerance diagrams. For the highest nominal application forces of the test program the mean coefficients of friction are summarized in a separate tolerance diagram and documented in tabular form. The average value of these mean coefficients of friction at a speed of 120 km/h at the highest nominal application force (excluding brake application with high initial temperatures) shall not vary more than 10 % upwards or 5 % downwards from the nominal coefficient of friction given in the tolerance diagram of the respective test program. At speeds above 120 km/h, the average values of these mean coefficients of friction shall not vary more than 10 % upwards or 10 % downwards from the nominal coefficients of friction.

5.6.3 Criteria for continuous brake applications

During continuous brake applications, after 10 seconds the instantaneous coefficient of friction shall stay inside the band defined by μ_{min} = 0,250 and μ_{max} = 0,500.

After 2 minutes the instantaneous coefficient of friction shall not vary more than 0,05 during any minute and the coefficient of friction shall stay inside the band defined by μ_{min} = 0,250 and μ_{max} = 0,500.

5.6.4 Criteria for bedding brake applications

The mean coefficient of friction of the bedded state shall be defined as the average of measured mean coefficient of friction of the last 5 braking stops carried out during the bedding section.

During the bedding-in phase, the mean coefficients of friction shall not exceed the following variations from the nominal value of the bedded state:

— ± 30 % from the 11th bedding-in brake application until 30 % of number of the bedding-in applications are finished;

— ± 15 % during the rest of the bedding-in process.

5.6.5 Coefficient of friction under high thermal load

For brake applications to a stand, which are done from a high initial temperature (approximately 140 °C, excluding brake application after continuous brake applications and for two consecutive emergency brake without cooling time), the mean coefficient of friction under otherwise similar conditions shall not vary by more than ± 15 % from the average of the mean coefficients of friction of brake applications initiated from the cold and dry condition.

5.6.6 Coefficient of friction under wet conditions

In wet conditions, with the highest nominal application force of test program S2.1 and T2 the mean coefficient of friction shall not vary – all other things being equal – by more than ± 15 % compared with the average of mean coefficients of friction obtained during braking under dry conditions. The mean coefficients of friction of the other brake applications to a stand of this test program shall not under-run the absolute value of μ_m = 0,250 under otherwise similar conditions.

5.7 Geometrical features of the brake pads

5.7.1 Brake pad shape

The SBP shall be designed in accordance with Annex F.

5.7.2 Brake pad wear

The design of the brake pads shall enable them to wear uniformly to a friction material thickness of 5 mm or defined by design specification.

5.7.3 Brake pad fixing

The brake pads should be affixed to the vehicle by pushing them into a dovetail. If the brake pad is used with a brake pad holder in accordance with EN 16451:2015 the dove tail shall be designed in accordance with Annex G.