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Železniške naprave - Kategorizacija prog za upravljanje vmesnika med dopustnimi obremenitvami vozil in infrastrukturo

Railway applications - Line categories for managing the interface between load limits of vehicles and infrastructure

Bahnanwendungen - Streckenklassen zur Behandlung der Schnittstelle zwischen Lastgrenzen der Fahrzeuge und Infrastruktur

Applications ferroviaires - Catégories de ligne pour la gestion des interfaces entre limites de charges des véhicules et de l'infrastructure

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Railway applications - Line categories for managing the interface between load limits of vehicles and infrastructure

Applications ferroviaires - Catégories de ligne pour la gestion des interfaces entre limites de charges des véhicules et de l'infrastructure

Bahnanwendungen - Streckenklassen zur Behandlung der Schnittstelle zwischen Lastgrenzen der Fahrzeuge und Infrastruktur

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European foreword

This document (EN 15528:2021) has been prepared by Technical Committee CEN/TC 256 “Railway application”, 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of an identical text or by endorsement, at the latest by June 2022, and conflicting national standards shall be withdrawn at the latest by June 2022.

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.

This document supersedes EN 15528:2015.

Significant technical changes between this document and EN 15528:2015 are:

— All information about dynamic compatibility was deleted including Annexes C, D, E and P (in future part of a TR prepared by TC250/SC1/WG 3/ TG DIBRST);

— For coaches and multiple units an additional categorization is introduced for different values of standing passengers per m² in the load case Design mass with exceptional payload (MXD) according to EN 15663:2017+A1:2018;

— Clarification of the informative character of Annex C (Annex F in the previous version) about speeds which do not require additional dynamic compatibility checks.

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

The existing European heavy rail system (see EN 17343:2020) consists of elements designed for varying historical requirements. Most civil engineering elements of the heavy rail system were built before the introduction of the Technical Specifications for Interoperability (TSIs) and the Eurocodes for the design of structures.

This document specifies a line classification system to manage the interface between the load limits for rail vehicles and the payload limits for freight wagons and the vertical load carrying capacity of a line.

The line classification system takes into account parameters such as:

— axle load (P);

— geometrical aspects relating to the spacing of axles;

— mass per unit length (p);

— speed;

and provides a transparent method for determining whether the vertical loading characteristics of vehicles are compatible with the load carrying capacity of lines on the network.

The line classification system utilizes a suite of line categories specified in this standard by a load model.

1 Scope

This document is applicable to the lines with standard track gauge (1 435 mm) and wider track gauges of the heavy rail system[1] and the vehicles that are operated on these lines. This includes machines used for construction, maintenance, inspection, repair and renewal when they are operated in running mode, but not, when they are in working or travelling mode.

This document specifies methods of classification of existing and new lines of the heavy rail system and the categorization of rail vehicles.

This document gives guidance to a reliable and established management of the interface between rail vehicles and the heavy rail network and does not impose any requirements on either vehicles or infrastructure.

The application of this document enables to ensure the static route compatibility between a rail vehicle and the heavy rail network with respect to the vertical load carrying capacity.

It contains requirements relevant to:

— classification of the vertical load carrying capacity of lines of the heavy rail network;

— allocation of rail vehicles to line categories (categorization);

— determination of payload limits of freight wagons.

This document does not apply to:

— assessments of compatibility based on the parameter axle load alone;

— compatibility checks for cases where an additional dynamic analysis is required (for example according to EN 1991-2);

— requirements relating to the maximum total mass or maximum length of a train;

— the system used in Great Britain, where all lines and vehicles are classified in accordance with the RA (Route Availability) System. A guide to the equivalent line categories in accordance with this European Standard is given in Annex F;

— the publication of line categories.

The requirements of this document do not replace any regulations related to running behaviour of vehicles described by the assessment quantities for running safety, track loading and ride characteristics (see EN 14363).

[1] According to a note in EN 17343:2020, the heavy rail system "has typically an infrastructure which is designed for an axle load of at least 17 t". This European standard covers also parts of the networks with lower load capacities.

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 1991-2, *Eurocode 1: Actions on structures - Part 2: Traffic loads on bridges*

EN 15663:2017+A1:2018, *Railway applications - Vehicle reference masses*

EN 15877-1, *Railway applications - Marking on railway vehicles - Part 1: Freight wagons*

3 Terms, definitions, symbols and abbreviated terms

3.1 Terms and definitions

For the purposes of this document, the following terms and definitions 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/

3.1.1
associated maximum speed
local maximum speed for which the line category is valid

3.1.2
axle load
P
sum of the static vertical wheel forces exerted on the track through a wheelset or a pair of independent wheels divided by *g*

Note 1 to entry: In this standard “load” and “force” are described with units of “mass” (kg or t).

3.1.3
axle spacing
design values of the distances between the centres of adjacent axles

3.1.4
bending moment
designation of an internal moment (e.g. in kNm) of a beam as used in structural design

3.1.5
categorisation of vehicles
statement of the vertical loading characteristics of a heavy rail vehicle, according to the combination of axle loads and axle spacing, by allocation of a line category

3.1.6
classification of infrastructure
statement of the load carrying capacity of infrastructure on a line by allocation of a line category and related speed information

3.1.7
compatibility
demonstration of the satisfactory interface between the load effects of the vehicles and the load capacity of the infrastructure

3.1.8
length over buffers
L
length over buffers or between coupling planes in case of no buffers

3.1.9
line
track or tracks between two locations forming a part of the heavy rail network

3.1.10
line category
specific load model based on reference wagons as described in Annex A

3.1.11
line speed
general maximum speed of traffic on a route

3.1.12
load limit
maximum allowable payload for a wagon related to each line category

3.1.13
load model
model specified by a specific formation of reference wagons

3.1.14
locomotive class
reference vehicle with representative locomotive parameters

Note 1 to entry: In this standard, power heads are considered as locomotives.

3.1.15
mass per unit length
p
mass of a vehicle or unit divided by length over buffers

3.1.16
maximum passenger traffic speed/maximum freight traffic speed
additional information giving the general limit to the maximum traffic speed on a line according to the type of traffic

3.1.17
reference wagon
virtual vehicle used as a module of loading for a load model defined by axle load, axle spacing and mass per unit length

3.1.18
route
path of a train between two locations of the network along one or more lines

3.1.19
series of locomotives
locomotives designed to be equal (the same axle spacing and the same nominal values for mass m_{nom} and, axle loads $P_{i,nom}$)

3.1.20
shear force
designation of an internal force (e.g. in kN) of a beam as used in structural design

3.1.21
special vehicles
vehicles which are designed for maintenance, inspection or renewal of infrastructure elements or for special transport purposes where the fleet is operated with a low mileage compared to normal heavy rail vehicles including:

a) maintenance vehicles including:

   1) cranes and matching wagons;
   2) on-track machines (see EN 14033 (all parts));
   3) road rail machines (see EN 15746 (all parts));
   4) demountable machines (see EN 15955 (all parts));
   5) trailers (see EN 15954 (all parts));

b) monitoring and inspection vehicles, including:

   1) track inspection vehicles;
   2) catenary inspection vehicles;

c) special transport vehicles, including:

   1) transformer transporter;
   2) crucible transporters;
   3) loaded wagons with more than eight axles (UIC 502-1).

3.1.22
wheel load
Q
static vertical wheel/rail contact forces divided by g

Note 1 to entry: The terminology in this standard for “load” and “force” is used with the meaning and units of “mass” (kg or t).

3.2 Symbols and abbreviated terms

$2a^*$	bogie spacing between pivot centres within a vehicle	m
$2a^*_{adopted}$	adopted value of $2a^*$ used in Annex P	m
$2a^*_{table}$	$2a^*$ value in tables of Annex P	m
$2a^*_{unit}$	$2a^*$ value of a MU unit used in Annex P	m
$2a^+$	axle spacing in a bogie	m
$2a^+_{table}$	$2a^+$ value in tables of Annex P	m
$2a^+_{unit}$	$2a^+$ value of a MU unit used in Annex P	m
AB	articulated bogie	—
a	distance between axles	m
b	distance from end axle to the end of the nearest coupling plane	m
c	distance between two inside axles	m
CB	conventional bogie	—
ETCS	European Train Control System	—
HSLM	High Speed Load Model	—
d_n	distance between axle n and axle (n-1)	m
g	acceleration due to gravity	9,81 m/s^2
L	length over buffers	m
L_Coa	coach length	m
m	mass	t
m_{nom}	nominal values for mass	t
$m_{nom,excess}$	modified nominal value for mass due to excess of tolerances	t
MU	multiple unit	—
n	axle number	—
p	mass per unit length	t/m
P_i	axle load of axle i	t
$P_{i,nom}$	nominal value for axle load of axle i	t
$P_{LineCategory}$	maximum axle load for a Line Category	t
$P_{nom,excess}$	modified nominal value for axle load due to excess of tolerances	t
P_{red}	reduced value of axle load	t
P_{unit}	maximum axle load within the unit	t
Q_i	mean wheel load of axle i	t
Q_{ir}/Q_{il}	wheel load of axle i right or left	t
RA	Route Availability	—
SA	single axle	—
s_n	distance between axle n and axle 1	m

u_1+u_2	bogie spacing between pivot centres of adjacent vehicles	m
u_3	overhang of end coaches	m
u_{unit}	overhang value of a MU unit used in Annex P	m
u_{table}	overhang value in tables of Annex P	m
UIC	International Union of Railways	—
v	speed	km/h

4 Classification system

4.1 Definition of line categories

The use of a classification system using line categories permits easy understanding of the load-related compatibility of vehicles and infrastructure. A flow chart of the classification of infrastructure and the categorization of vehicles is shown in Annex B.

The line category resulting from the classification process for infrastructure represents the ability of the infrastructure (track, track substructures, earthworks, civil engineering structures) to withstand the static vertical loads imposed by vehicles on the line or section of line for regular service.

Each line category (a10, a12, a14, A, B1, B2, C2, C3, C4, D2, D3, D4, D5, D4xL and also E4 and E5, E6) is specified by a load model based on reference wagons specified by the characteristics given in Annex A:

— axle load;

— geometrical characteristics of the spacing of axles;

— length of the vehicle.

The value “mass per unit length” of the reference wagon is determined from the above parameters.

4.2 Correlation to types of vehicles

The load effects of different vehicle types are compared to the load models defining the different line categories.

The majority of vehicles including freight wagons with their corresponding payload are covered by the line categories A, B1, B2, C2, C3, C4, D2, D3, D4.

Line categories D5, E4, E5 and E6 are specified exclusively for freight wagons exceeding the parameters of the line categories D4 and D4xL.

Locomotives are covered additionally by:

— line category D4xL (plus optional detailed specification for axle spacing ranges);

— locomotive classes L4 and L6.

Coaches and Multiple Units are covered additionally by:

— line categories a10, a12, a14 (plus optional detailed specification for axle spacing and vehicle lengths). Line categories a10, a12 and a14 have been specially developed for light heavy rail vehicles with up to 14 t axle loads.

NOTE Wheel load measuring devices attached to the track and/or fitted to vehicles can assist with checking the compatibility of vehicles categorized above D4 or D4xL with the infrastructure.

4.3 Correlation between line category and speed

4.3.1 General

The classification of infrastructure applies to all types of heavy rail vehicles, which can have different maximum speeds (e.g. freight and passenger traffic). Additional information defining the maximum speed corresponding to the line category shall be stated.

As a result of the classification of infrastructure, additional information specifying the line classification can be given to cover two or more combinations (e.g. different maximum speeds and associated line categories for passenger and freight trains).

NOTE Examples illustrating information about line classification and relationship with speed are given in Annex E.

The combinations used for publication should be in accordance with legal, technical and operational requirements (e.g. ETCS speed levels).

The local line speed shall be taken into account for the classification of engineering structures (see 5.1) and other relevant infrastructure elements (see 5.2).

The line category and associated maximum speed shall be considered as a single combined quantity.

4.3.2 Freight traffic

When classifying infrastructure lines into line categories, dynamic effects up to the maximum freight traffic speed (maximum 120 km/h) shall be respected. 120 km/h corresponds to the maximum speed for conventional freight traffic and is the limit of validity for freight traffic using line categories. In excess of 120 km/h individual checks shall be carried out.

Optionally it is permissible to determine an additional higher line category at an associated lower speed (less than the maximum freight traffic speed).

In some situations, it is desirable to determine the line category at a lower speed to maximize the line category.

In addition, for D5, E4, E5 or E6 lines, an associated maximum speed for such traffic shall be stated together with the associated maximum speed for conventional line traffic of line category D4.

4.3.3 Mixed traffic and passenger traffic

On mixed traffic lines with passenger traffic, the line category at maximum freight traffic speed in 4.3.2 is generally sufficient and appropriate for the optimization of freight traffic.

For vehicles and locomotives, categorized into the same or lesser line category as the line, and which run faster than the maximum freight traffic speed, additional checks starting on the basis of the maximum freight traffic speed shall be taken into account for the classification of engineering structures (see 5.1) and other relevant infrastructure elements (see 5.2).

If, for speeds over above 120 km/h and up to the maximum line speed different combinations of line categories and speed are specified, they shall be in accordance with general technical and operational requirements or restrictions.

Line Categories as classification information for speeds over 120 km/h can be related to vehicle types or types of traffic (see 5.1 and examples in informative Annex C and informative Annex E).

NOTE For some vehicle types, it is possible that other regulations require additional dynamic compatibility checks at different speed levels to demonstrate compatibility.

5 Classification of infrastructure

5.1 Civil engineering structure

When classifying a line of a heavy rail system into line categories, the load carrying capacity of structures supporting the track on the line shall be determined and expressed using the load models of Annex A taking speed into account. The speed(s) and where relevant traffic types shall be in accordance with 4.2 and 4.3.

The method used to determine the load carrying capacity of structures (bridges and other structures supporting the track) shall take account of the condition of the existing structures and be in accordance with national requirements.

NOTE 1 Examples of typical methods used to determine the load carrying capacity of existing structures are given in Annex D.

The assessment of the load capacity of structures shall take the following into account:

— load models and combination of vehicles shall be applied to produce the most onerous load effects (e.g. on continuous beams parts of the load model which produce a relieving effect shall be neglected);

— dynamic load effects (e.g. using the dynamic factor for real trains in EN 1991-2);

— partial safety factors for railway traffic loads due to mass tolerances and potential overloading (see 6.1.2);

— existing operating and other restrictions relating e.g. to different types of traffic.

When determining the line classification and maximum operating speed for locomotives, it is permitted to take into account the reduced likelihood of overloading and cargo displacements (in comparison with other traffic types). Any reduction in partial safety factors for railway traffic loads should be in accordance with national requirements.

The load models specified in Annex A are for the classification of lines and are not to be used for the design of new structures. For the design of new structures, the rail traffic loading given in EN 1991-2 shall be used.

The resulting output of the classification process of each structure on a line shall satisfy the requirements of Clause 4.

To address the potential risk of adverse bridge dynamic effects, resulting from resonance and other excessive dynamic effects in the structure, the need to carry out additional dynamic checks shall be considered according to the risk arising from the combination of vehicle type and speed.

NOTE 2 Annex C provides guidance on combinations of vehicle type and speed which do not require dynamic compatibility checks on existing bridges.

5.2 Track construction, track substructure and earthworks

The load carrying capacity of the track, track substructure and earthworks shall be determined in accordance with national requirements. Typically, such methods take account of the type of rail and track components, sleeper spacing, track geometry, track quality, annual tonnage of traffic, inspection and maintenance regimes and other national requirements, etc.

For E4 and E5 traffic in networks with 1 435 mm track gauge, a maximum service speed of 100 km/h and a maximum cant deficiency of 100 mm are recommended (the recommendation for the cant deficiency can be adapted for networks with other track gauges). For E6 traffic a maximum speed of 80 km/h is recommended.

In order to establish an appropriate maximum speed for wagons with axle loads greater than 22,5 t for proposed speeds > 100 km/h, special studies should be undertaken to check the dynamic effects on the track.

The correspondence between the local track classification system and the line classification system specified in this document shall be determined.

The results shall be used to determine the line classification in accordance with this document with respect to the load carrying capacity of the track, track substructure and earthworks.

5.3 Infrastructures classification results

The classification of a line or a section shall be taken as the lesser of:

— the line classification of civil engineering structures determined in accordance with 5.1;

— the line classification of track, track substructures and earthworks determined in accordance with 5.2;

— relevant associated requirements relating to train speed;

— other general requirements including requirements relating to maximum permitted speeds depending on:

— types of traffic;

— type of vehicle and number of vehicles or units being integrated in the train;

— the number of axles of the train;

— other operating conditions;

— additional qualifications relating to the validity of the line classification.

The result of infrastructure classification shall include the permissible line category(ies) and their associated maximum speed(s) of each line or section of line. If necessary, additional speed regulations and operating requirements relating to locomotives (e.g. locomotive classes and associated maximum speed) or traffic types (e.g. maximum speed of freight traffic or passenger traffic) shall be considered.

For publication and implementation, the result of the infrastructure classification due to this standard should be adjusted according to international and national requirements including legal, technical and operational requirements.

Where the line classification related to associated speed is D4xL, D5, E4, E5 or E6, the maximum speed for line category D4 shall also be stated.

NOTE Examples of line classification result are given in Annex E.