

Railway applications — Gauges

Part 1: General — Common rules for infrastructure and rolling stock

ICS 45.020

National foreword

This British Standard is the UK implementation of EN 15273-1:2009.

The UK participation in its preparation was entrusted by Technical Committee RAE/1, Railway applications, to Subcommittee RAE/001/-/12, Railway applications – Gauging.

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

Gauging practices used in Great Britain are documented in Railway Group Standards, published for the GB main line railway industry by Rail Safety and Standards Board Limited (RSSB), www.rssb.co.uk. Railway Group Standards are freely available from www.rgsonline.co.uk.

The gauging practices used in Great Britain diverge significantly from the International Union of Railways (UIC) gauging practices used in much of the rest of Europe. Although BS EN 15273 Railway applications – Gauges defines a number of different gauging methodologies and applications, the underlying philosophy is that of the UIC method of gauging, which depends on the use of reference profiles. It should be noted, therefore, that BS EN 15273 and Railway Group Standards sometimes use the same terms, but with different meanings. The terminology used in one cannot therefore be used to interpret the requirements of the other.

National Annex NA gives the definitions used in Great Britain for some of the key terms used in BS EN 15273.

Except where a decision has been made to adopt standard European gauges and to use the associated gauging techniques documented in BS EN 15273, the gauges and gauging practices used on the GB main line railway should continue to be those documented in Railway Group Standards.

BS EN 15273 should be used where a decision has been made to adopt standard European gauges, and to use the associated gauging techniques.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

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 May 2010

© BSI 2010

ISBN 978 0 580 55703 3

Amendments/corrigenda issued since publication

Date	Comments

EUROPEAN STANDARD
NORME EUROPÉENNE
EUROPÄISCHE NORM

EN 15273-1

December 2009

ICS 45.020

English Version

**Railway applications - Gauges - Part 1: General - Common rules
for infrastructure and rolling stock**

Applications ferroviaires - Gabarits - Partie 1: Généralités -
Règles communes à l'infrastructure et au matériel roulant

Bahnanwendungen - Begrenzungslinien - Teil 1:
Allgemeines - Gemeinsame Vorschriften für Infrastruktur
und Fahrzeuge

This European Standard was approved by CEN on 3 October 2009.

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 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 Management Centre has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Bulgaria, 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.



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

Management Centre: Avenue Marnix 17, B-1000 Brussels

© 2009 CEN All rights of exploitation in any form and by any means reserved
worldwide for CEN national Members.

Ref. No. EN 15273-1:2009: E

AVA Documents
Document Sharing Hub

Contents

Page

Foreword.....	6
Introduction	7
1 Scope	8
2 Normative references	8
3 Terms and definitions	9
4 Symbols and abbreviations	17
5 Specific considerations for determination of parameters.....	30
5.1 Geometric overthrow	30
5.1.1 Geometric overthrow between the vehicle body	30
5.1.2 Additional geometric overthrow due to the bogies.....	31
5.2 Flexibility coefficient	32
5.3 Dissymmetry	33
5.4 Clearance between the wheelsets and the track	34
5.5 Additional overthrow	35
5.6 Roll centre	36
6 Gauges and gauging methods	36
6.1 General.....	36
6.1.1 Static gauge.....	38
6.1.2 Kinematic gauge	38
6.1.3 Dynamic gauge	39
6.1.4 Uniform structure gauge	40
6.1.5 Gauges and interoperability	40
6.1.6 Illustration and comparison of static and kinematic gauges in the transverse direction.....	40
6.1.7 Illustration of the dynamic gauge	43
6.2 Other gauging methods	44
6.2.1 General.....	44
6.3 Absolute gauging method	44
6.4 Comparative gauging method	45
7 Elements involved in the determination of a gauge.....	46
7.1 General.....	46
7.1.1 In the transverse direction	46
7.1.2 In the vertical direction	48
7.2 Detailed analysis of the details to be shared between vehicle and infrastructure depending of the method of determination of each of the gauges	49
7.2.1 In the transverse direction	49
7.2.2 In the vertical direction	71
7.2.3 Contact ramps.....	83
7.2.4 Rail and rail brake zone.....	85
8 Pantograph gauge	89
8.1 Pantograph kinematic gauge.....	89
8.1.1 General principle.....	89
8.1.2 Elements to be taken into account by the infrastructure	93
8.1.3 For the vehicle.....	94
8.2 Pantograph dynamic gauge.....	98
8.2.1 Values taken into account by the vehicle	98
8.2.2 Values taken into account by the infrastructure	98
Annex A (normative) Catalogue of gauges.....	99

A.1	Static gauges	99
A.2	Kinematic gauges	100
A.3	Dynamic gauges	101
A.4	Uniform gauges	101
Annex B	(normative) Reference profiles and associated rules for static gauges	102
B.1	Static gauges G1 and G2	102
B.1.1	Upper parts of static gauges G1 and G2	102
B.1.2	Lower parts of static gauges GIS1 and GIS2	104
B.2	Static gauges GA, GB and GC	107
B.2.1	Lateral part	107
B.2.2	Static reference profiles for the upper parts	107
B.2.3	Associated rules	108
B.3	Static gauge GB1 and GB2	110
B.3.1	Lateral part	110
B.3.2	Static reference profiles for the upper parts	110
B.3.3	Associated rules	112
B.4	Static gauges OSJD	113
B.4.1	General comment	113
B.4.2	Static reference profiles for the upper parts	113
B.4.3	Associated rules	116
B.4.4	Static reference profiles for the lower parts	116
B.5	Static gauge for the upper parts of W6a	118
B.5.1	Static reference profile for the upper parts of W6a	118
B.5.2	Associated rules	118
B.5.3	Taking the roll into account	119
B.5.4	Infrastructure allowance in the transverse direction	119
B.5.5	Vertical geometric overthrow upwards and vertical allowance of the infrastructure	119
B.5.6	Vehicle allowances in the transverse direction	120
B.5.7	Vehicle allowances in the vertical direction	120
B.6	Static gauge for the upper parts of UK1 [B]	120
B.6.1	Static reference profile for the upper parts of UK1 [B]	120
B.6.2	Associated rules	121
B.6.3	Taking the roll into account	121
B.6.4	Infrastructure allowance in the transverse direction	121
B.6.5	Vertical geometric overthrow upwards and vertical allowance of the infrastructure	121
B.6.6	Vehicle allowances in the transverse direction	122
B.6.7	Vehicle allowances in the vertical direction	122
B.7	Static gauge FIN 1	122
B.7.1	General comment	122
B.7.2	Static reference profile for the upper parts	122
B.7.3	Associated rules	124
B.7.4	Position of the platforms	124
Annex C	(normative) Reference profiles and associated rules for kinematic gauges	126
C.1	Kinematic gauges G1 and G2	126
C.1.1	Upper part of gauges G1 and G2	126
C.1.2	Gauges of the lower parts of GIC1, GIC2	128
C.2	Kinematic gauges GA, GB and GC	131
C.2.1	Lateral part	131
C.2.2	Kinematic reference profiles for the upper parts	132
C.2.3	Associated rules	132
C.3	Kinematic gauges GB1 and GB2	134
C.3.1	Lateral part	134
C.3.2	Kinematic reference profiles for the upper parts	134
C.3.3	Associated rules	135
C.4	Kinematic gauge GIC3	137
C.4.1	Upper parts	137
C.4.2	Reference profile for the lower parts	137
C.4.3	Associated rules	138

C.5	Kinematic gauge FR3.3	138
C.5.1	Lateral part	138
C.5.2	Kinematic reference profile for the upper parts	138
C.5.3	Associated rules	139
C.6	Kinematic gauges BE1, BE2 and BE3	140
C.6.1	Lateral part	140
C.6.2	Kinematic reference profiles for the upper parts	140
C.6.3	Associated rules	143
C.6.4	Kinematic reference profiles for the lower parts	144
C.7	Kinematic gauges NL1 and NL2	145
C.7.1	Reference profiles of kinematic gauges NL1 and NL2	145
C.7.2	Associated rules	146
C.8	Kinematic gauges PTb, PTb+ and PTc	146
C.8.1	Lateral part	146
C.8.2	Associated rules	148
C.8.3	Taking the roll into account	149
C.8.4	Vertical geometric overthrow upwards and vertical allowance of the infrastructure	149
C.8.5	Kinematic reference profiles for the lower parts	149
C.8.6	Vertical geometric overthrow downwards and vertical allowance of the infrastructure	150
C.9	Kinematic gauge DE1	150
C.9.1	General	150
C.9.2	Kinematic reference profiles	151
C.9.3	Associated rules	152
C.9.4	Taking the roll into account	153
C.9.5	Vertical geometric overthrow downwards and vertical allowance of the infrastructure	153
C.10	Kinematic gauge DE2	153
C.10.1	General	153
C.10.2	Kinematic reference profiles	154
C.10.3	Associated rules	155
C.10.4	Taking the roll into account	155
C.10.5	Vertical geometric overthrow downwards and vertical allowance of the infrastructure	156
C.11	Kinematic gauge DE3	156
C.11.1	Kinematic reference profiles	156
C.11.2	Associated rules	157
Annex D (normative)	Reference profiles and associated rules for dynamic gauges	158
D.1	Dynamic gauge SEa and SEc	158
D.1.1	Dynamic reference profile SEa	158
D.1.2	Dynamic reference profile SEc	159
D.1.3	Associated rules	160
D.2	Dynamic gauge for the lower parts of W6a	161
D.2.1	Dynamic reference profile for the lower parts of W6a	161
D.2.2	Associated rules	162
D.2.3	Infrastructure allowances in the transverse direction	162
D.2.4	Infrastructure allowances in the vertical direction	162
D.2.5	Vehicle allowances in the transverse direction	163
D.2.6	Vehicle allowances in the vertical direction	163
D.3	Dynamic gauge UK1	163
D.3.1	Dynamic gauge for the lower parts of UK1[A]	163
D.3.2	Associated rules	164
D.3.3	Taking the roll into account	165
D.3.4	Infrastructure allowances in the transverse direction	165
D.3.5	Infrastructure allowances in the vertical direction	165
D.3.6	Vehicle allowances in the transverse direction	165
D.3.7	Vehicle allowances in the vertical direction	166
D.4	Dynamic gauges for the upper parts of UK1 [D]	166
D.4.1	Basic principle	166
D.4.2	Dynamic reference profile for the upper parts of UK1[D]	167
D.4.3	Associated rules	167
D.4.4	Infrastructure allowances in the transverse direction	168

D.4.5	Infrastructure allowances in the vertical direction	168
D.4.6	Vehicle allowances in the transverse direction	168
D.4.7	Vehicle allowances in the vertical direction	168
Annex E	(normative) Uniform gauges	169
E.1	General information on gauges GUC, GU1, GU2, UK1[D] and Z -GČD	169
E.2	Uniform gauge GU1	169
E.2.1	Basic data	170
E.3	Uniform gauge Z -GČD	171
E.3.1	Uniform reference profile	171
E.3.2	Basic data	173
Annex F	(normative) Specific rules in the vertical direction	174
F.1	Passing over link spans onto ferries	174
F.2	Marshalling humps	175
F.2.1	Agreement for the gauges of group G1, G2, GA, GB, GB1, GB2, GC, FR3.3, BE1, BE2, BE3, ...	175
F.2.2	Other agreements	178
Annex G	(normative) Geometric overthrow to be considered in the additional overthrows for the turnouts	180
G.1	General	180
G.2	Turnout laid on a straight track	180
G.2.1	Overthrow on the turnout route	180
G.2.2	Overthrow on the through route	181
G.3	Turnout laid on a curved track	182
G.3.1	Overthrow on the turnout route	182
G.3.2	Overthrow on the through route	183
Annex H	(normative) Rules relating to pantographs	185
H.1	Catalogue of standard heads	185
H.2	Reference vehicle parameters	185
H.3	Electrical insulating allowances	186
H.4	Characteristics of the collection system	186
H.5	Specific cases	187
H.5.1	Pantograph gauges linked to gauges BE1, BE2 and BE3	187
Annex I	(normative) Rules relating to access steps and platform installation	189
I.1	Actual and conventional gap between step and platform	189
I.1.1	Position of the platforms	191
I.1.2	Position of the steps	194
Annex J	(informative) Widening of the vehicles as a function of the possibilities offered by the infrastructure	196
J.1	General	196
J.2	Possible gain on the track centre side	196
J.2.1	Basic principle	196
J.2.2	Application	198
J.3	Possible gain on the structure side	199
Annex K	(normative) Application of the probability theory in conjunction with the limit values taking into account the oscillations and dissymmetry in the determination of allowance M₁	200
K.1	Introduction	200
K.2	Reminder of some principles of the probability theory	200
K.3	Taking into account oscillations and dissymmetry in the determination of allowance M ₁	201
K.3.1	Additional comments	202
Annex L	(informative) A-deviations	204
	Bibliography	206

Foreword

This document (EN 15273-1:2009) 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 June 2010, and conflicting national standards shall be withdrawn at the latest by June 2010.

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 document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive(s).

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, 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 the United Kingdom.

Introduction

This document is the first of a series of three parts of the European Standard covering gauges:

- Part 1 covers general principles, phenomena shared by the infrastructure and by the rolling stock, reference profiles and their associated rules;
- Part 2 gives the rules for dimensioning the vehicles as a function of their specific characteristics for the relevant gauge and for the related calculation method;
- Part 3 gives the rules for dimensioning the infrastructure in order to allow vehicles built according to the relevant gauge taking into account the specific constraints to operate within it.

This standard defines the gauge as a one-to-one agreement between infrastructure and vehicle.

The aim of this standard is to define the space to be cleared and maintained to allow the running of rolling stock, and the rules for calculation and verification intended for sizing the rolling stock to run on one or several infrastructures without interference risk.

This standard defines the responsibilities of the following parties:

- a) for the infrastructure:
 - 1) gauge clearance,
 - 2) maintenance;
 - 3) infrastructure monitoring.
- b) for the rolling stock:
 - 1) compliance of the operating rolling stock with the gauge concerned;
 - 2) maintenance of this compliance over time.

This standard includes a catalogue of various railway gauges implemented in Europe, some of which are required to ensure the interoperability, while others are related to more specific applications. This standard does not exclude the possibility of implementing other gauges not listed in the catalogue.

1 Scope

This European Standard is applicable by authorities involved in railway operation and may also be applied for light vehicles (e.g. trams, metros, etc. running on two rails) and their associated infrastructure, but not for systems such as rail-guided buses.

It allows vehicles and infrastructures to be dimensioned and their compliance to be checked relative to the gauging rules.

For the rolling stock and for the infrastructure, this standard is applicable to new designs, to modifications and to the checking of vehicles and infrastructures already in use.

This document EN 15273-1 covers:

- the general principles;
- the various elements and phenomena affecting the determination of gauges;
- the various calculation methods applicable to the elements shared by the infrastructure and by the rolling stock;
- the sharing rules for elements taken into account in calculations specific to the infrastructure and to the vehicle;
- a catalogue of European gauges.

This document does not cover:

- conditions to be met to ensure safety of passengers on platforms and of persons walking along the tracks;
- conditions to be met by the fixed equipment maintenance machines in active position;
- the space to be cleared for the running track of rubber-tyred metros and other vehicles;
- rules applicable to extraordinary transportation, however some formulae may be used;
- rules applicable to the design of the overhead line;
- rules applicable to the design of the current collection on a third rail;
- simulation methods for the running of vehicles, therefore, it does not confirm the validity of existing simulations;
- verification rules of wagon loadings;
- coding methods for combined transportation;
- infrastructure gauges for very small curve radii (e.g. $R < 150$ m for gauge G1).

2 Normative references

The following referenced 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 14067-2, *Railway applications — Aerodynamics — Part 2: Aerodynamics on open track*

EN 14067-3, *Railway applications — Aerodynamics — Part 3: Aerodynamics in tunnels*

EN 14363, *Railway applications — Testing for the acceptance of running characteristics of railway vehicles — Testing of running behaviour and stationary tests*

EN 15273-2, *Railway applications — Gauges — Part 2: Rolling stock gauges*

EN 15273-3:2009, *Railway applications — Gauges — Part 3: Structure gauges*

prEN 15313, *Railway applications — In-service wheelset operation requirements — In-service and off-vehicle wheelset maintenance*

EN 50367, *Railway applications — Current collection systems — Technical criteria for the interaction between pantograph and overhead line (to achieve free access)*

EN 50119, *Railway applications — Fixed installations — Electric traction overhead contact lines*

3 Terms and definitions

For the purposes of this European Standard, the following terms and definitions apply.

3.1

(track) running surface

virtual plane coplanar with the rail tops of a track

3.2

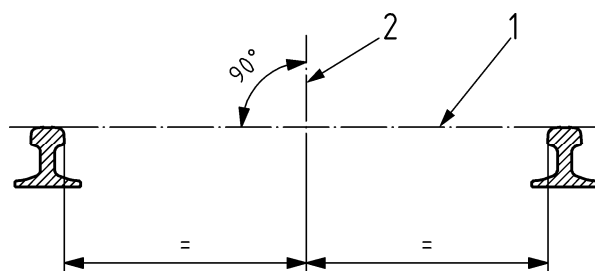
normal co-ordinates

are measured in relation to the orthogonal axes defined in a transverse plane, normal to the longitudinal centreline of the rails in the nominal position on a theoretically perfect track

One of these axes, commonly referred to as the horizontal axis, is coplanar with the running surface.

The other axis, commonly referred to as the vertical axis, is perpendicular to the running surface and is equidistant from the rails.

For calculation purposes, the vertical axis is used as a common reference for the infrastructure and for the vehicle (see Figure 1).



Key

1 running surface

2 centreline of the vehicle and of the track

Figure 1 — Reference axes

3.3
gauge
set of rules including a reference profile and its associated calculation rules allowing definition of the outer dimensions of the vehicle and the space to be cleared by the infrastructure

NOTE According to the calculation method implemented, the gauge will be a static, kinematic or dynamic one.

3.4
reference profile (RP)
line specific to each gauge, representing the cross-section shape and used as a common basis to work out the sizing rules of the infrastructure and of the vehicle

3.5
upper parts, lower parts
upper parts correspond to the upper zone of the gauge and the lower parts correspond to the lower zone of the gauge

NOTE The limit between the two parts is defined for each gauge.

3.6
associated rules
mathematical laws associated with each reference profile in order to size the infrastructure or a vehicle

3.7
static gauge
combination of the specific reference profile and its associated static rules

3.8
kinematic gauge
combination of the specific reference profile and its associated kinematic rules

3.9
dynamic gauge
combination of the specific reference profile and its associated dynamic rules

3.10
absolute gauging method
directory of the reference position of structures along a given route and of the dynamic rules associated with this route

3.11
comparative gauging method
set of rules allowing the comparing of the swept envelopes of various vehicles on the basis of their dynamic movements

3.12
geometric overthrow (Dpl_i or Dpl_a)
difference between the distance, measured parallel to the running surface and in the transverse direction, of a part of the vehicle under consideration to the centre of a curved track or radius R and the distance of this same part, in the same conditions, to the centre of a straight track

NOTE See detailed explanation in 5.1.

3.13

flexibility coefficient (s)

ratio of the angle η (between the body tilted on its suspension with the plane perpendicular to the running surface) to the angle δ (between the running surface and the horizontal plane with the vehicle stationary on a canted track)

NOTE See detailed explanation in 5.2.

3.14

dissymmetry (η_0)

angle η_0 that would be made by the centreline of the body of a stationary vehicle on a level track relative to the vertical in the absence of any friction.

NOTE See detailed explanation in 5.3.

3.15

clearance between wheelset and track ($\frac{l-d}{2}$)

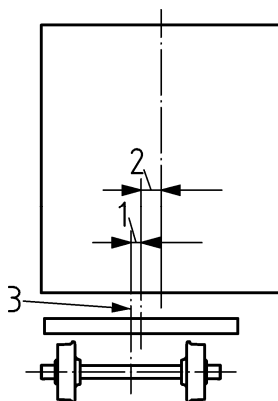
transverse displacement of the wheelset in relation to the track centre.

NOTE See detailed explanation in 5.4.

3.16

transverse clearance between wheelset and body ($q + w$)

sum of the amount " q " at the level of the axle boxes and of the amount " w " between the bogie frame and the body (see Figure 2)



Key

- 1 transverse clearance " q " between wheelset and bogie frame or between wheelset and body for vehicles not fitted with bogies
- 2 transverse clearance " w " between body and bogie
- 3 centre of wheelset

Figure 2 — Transverse clearances q and w

3.17

coefficient of displacement (A)

parameter " A " to take into account the orientation of the bogie and body position as a result of the wheelset position on the track

3.18

additional overthrow (S_i or S_a)

excess geometric overthrow of the vehicle beyond the reference profile

NOTE See detailed explanation in 5.5.

3.19

roll centre (C)

rotational centre of the body

NOTE See detailed explanation in 5.6.

3.20

cant (D), (D_{th}), cant deficiency (I) and cant excess

cant D is the difference in height of the centres of the two rails of a track at the level of the running surface.

The theoretical equilibrium cant D_{th} is the cant for which the resultant of the centrifugal acceleration and gravity is perpendicular to the running surface at a given velocity.

Cant deficiency I is the difference between the applied cant and the theoretical equilibrium cant:

$$I = D_{th} - D \quad (1)$$

A negative value of cant deficiency denotes cant excess.

3.21

quasi-static roll

corresponds to the roll movements of the vehicle due to the roll of the sprung weight under the effect of the transverse accelerations due to gravity (see Figure 14 a)) or to the centrifugal force not compensated by the cant (see Figure 14 b)).

This roll is referred to as quasi-static because it is determined for a moving vehicle on the basis of a transverse acceleration considered as steady and taking no account of the additional dynamic or random effects

3.22

random dynamic movements

additional oscillations of the vehicle, in relation to its quasi-static position, generated by the interaction of the vehicle and the track resulting from the condition of the latter and the running speed.

They are generated by the dynamic reactions of the vehicle due to some layout defects such as:

- track geometry;
- sudden layout variations in the vicinity of turnouts;
- elastic deformation and the degradation of track due to traffic;
- a sequence of rail joints generating resonance phenomena;
- hunting movements;
- effects of cross winds and aerodynamic phenomena

3.23

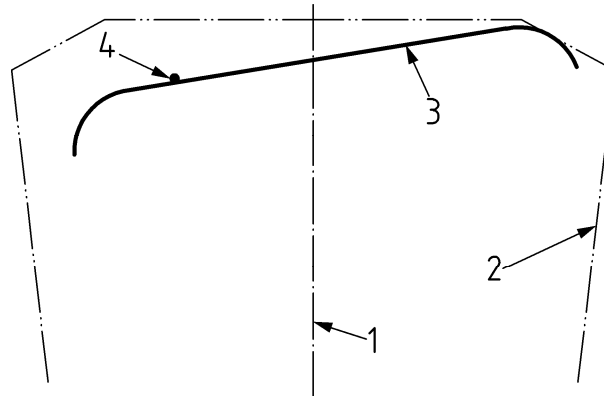
pantograph gauges and interface with the overhead line

specific reference profile combined with specific associated rules allowing verification that the pantograph head remains inside the allotted space, and location of infrastructure structures at a sufficient mechanical and electrical distance according to the pantograph head type used with live or insulated parts

3.23.1

pantograph gauge

reference profile with its associated rules allowing verification that the pantograph head in a raised position remains within the allotted space (see Figure 3)



Key

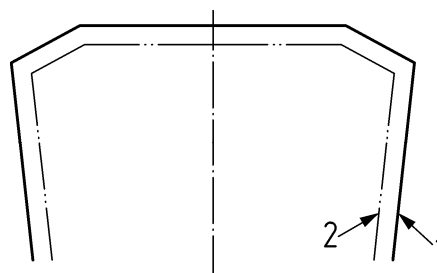
- 1 track centreline
- 2 pantograph reference profile
- 3 displaced pantograph head
- 4 contact wire raised by the pantograph

Figure 3 — Pantograph gauge

3.23.2

mechanical structure gauge

reference profile and its associated rules allowing the definition of the space to be cleared by all the structures in order to ensure passage of the pantograph in raised position, taking account of the maintenance allowances and of the displacements considered by the infrastructure (see Figure 4)



Key

- 1 mechanical structure gauge
- 2 pantograph reference profile

Figure 4 — Mechanical structure gauge

3.23.3

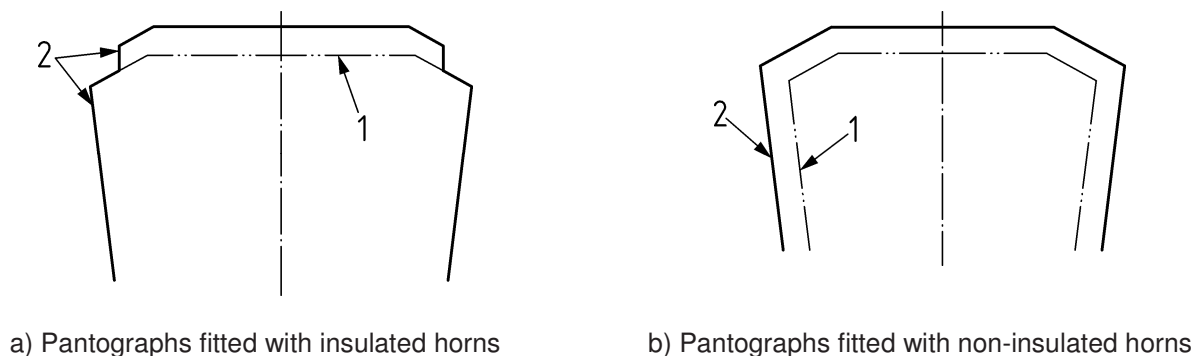
electrical insulating allowance

clearance to be maintained between two parts at different potentials in given atmospheric conditions in order to ensure electrical insulation

3.23.4

electrical structure gauge

reference profile and its associated rules allowing the definition of the space to be cleared taking account of the required electrical insulating allowance in relation to the live parts of the pantograph in the raised position (see Figure 5)



Key

- 1 pantograph reference profile
- 2 electrical structure gauge

Figure 5 — Electrical structure gauge

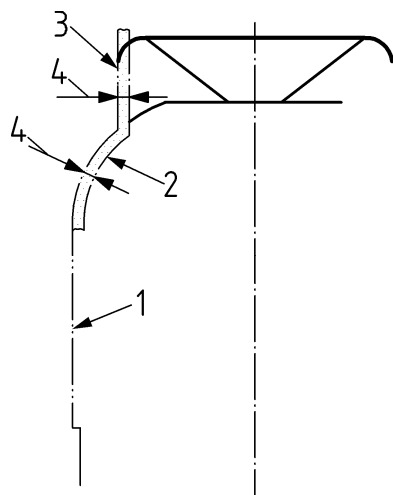
3.23.5

gauge for live roof-mounted parts

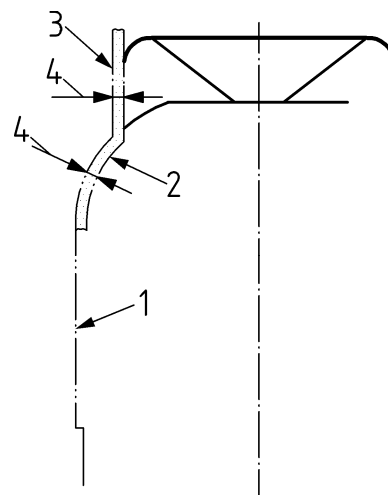
reduced gauge in relation to the maximum vehicle construction gauge taking account of a sufficient insulating clearance to the non-live parts of the infrastructure (see Figure 6)

Live parts are electrically non-protected parts of the vehicle.

They are not allowed to penetrate the hatched area.



a) Pantograph with insulated horns



b) For pantographs fitted with non-insulated horns

Key

- 1 maximum vehicle construction gauge
- 2 space which shall not be penetrated by non-insulated parts likely to remain live
- 3 pantograph gauge
- 4 electrical insulating clearance

Figure 6 — Gauge of live non-protected roof-mounted parts

3.24

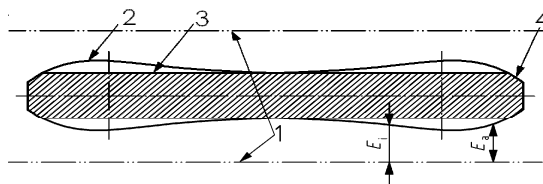
reference vehicles

theoretical or actual vehicles the parameters of which are used to establish the rules associated with a reference profile to obtain a gauge

3.25

maximum vehicle construction gauge

maximum volume obtained by applying the associated rules giving reductions E_i and E_a to be subtracted in relation to the reference profile (see Figure 7)



Key

- 1 reference profile
- 2 maximum vehicle construction gauge
- 3 effective construction gauge of the vehicle body
- 4 tapering
- E_i transverse reduction in relation to the reference profile for cross-sections between bogie centres
- E_a transverse reduction in relation to the reference profile for cross-sections beyond bogie centres

Figure 7 — Space available for the construction of a vehicle

3.26

structure gauge

according to the application, the following definitions are used:

3.26.1

structure limit gauge

defines the space not to be encroached upon at any time and fixes the limit for normal operation. It is used to ensure that structures allow free passage

Consequently, no structure is allowed to penetrate this space at any time

3.26.2

structure installation limit gauge

gives the space to be cleared taking into account a maintenance allowance defined according to the line speed and to the track quality at the time of the structure installation

When maintenance allowances have been fully used, a mandatory minimum clearance shall always remain to allow the operation of the vehicles

3.26.3

structure installation nominal gauge

in addition to maintenance allowances, the structure installation nominal gauge takes account of safety allowances and of reserved allowances defined for the infrastructure, e.g. of the running of special consignments, of line speed increase, strong cross winds, aerodynamic effects etc.

3.26.4

uniform structure gauge

gauge of constant cross-section used for the infrastructure

3.27

swept envelope

cross-section perpendicular to the running surface encompassing all the points swept by the vehicle under consideration with its dynamic displacements in any possible position combined with running and operating conditions on a track of a given quality

NOTE A series of swept envelopes makes it possible to determine the volume swept on a given route.

4 Symbols and abbreviations

For the purposes of this European Standard, the symbols and abbreviations given in Table 1 are applicable.

Table 1 — Symbols and abbreviations

Symbol	Designation	Unit	Symbol number
a	Distance between end axles of vehicles not fitted with bogies or between bogie centres	m	1.001
a_r	Wheelbase "a" of the reference vehicle	m	1.002
A	Coefficient of displacement		1.003
Abt	Reduction allowed on the pantograph displacement value	m	1.004
Abt_0	Reduction allowed on the pantograph displacement value at the upper verification point	m	1.005
Abt	Reduction allowed on the pantograph displacement value at the lower verification point	m	1.006
b	Semi-width or distance parallel to the running surface, relative to the track centreline or of the vehicle	m	1.007
b'_q	Actual installation distance of the platforms, measured from the rail running edge	m	1.008
b_b	Thickness of the wheel flanges	m	1.009
$b_{b\max}$	Maximum thickness of the wheel flanges	m	1.010
$b_{b\min}$	Minimum thickness of the wheel flanges	m	1.011
$b_{RP\text{kin}}$	Semi-width of the kinematic reference profile	m	1.012
$b_{RP\text{dyn}}$	Semi-width of the dynamic reference profile	m	1.013

Table 1 (continued)

Symbol	Designation	Unit	Symbol number
$b_{RP_{st}}$	Semi-width of the static reference profile	m	1.014
$b_{f_{max}}$	Maximum back-to-back dimension	m	1.015
$b_{f_{min}}$	Minimum back-to-back dimension	m	1.016
b_G	Semi-spacing of side bearers	m	1.017
b_{inf}	Semi-width of the infrastructure	m	1.018
b_{gap_0}	Standard width of the gap between the platform and the step	m	1.019
$b_{gap_{actual}}$	Actual width of the gap between the platform and the step	m	1.020
b_q	Semi-width of the platform installation	m	1.021
b_{q0}	Semi-width of the standard platform installation	m	1.022
b_{q0a}	Semi-width of the standard platform installation on the outside of a curve	m	1.023
b_{q0i}	Semi-width of the standard platform installation on the inside of a curve	m	1.024
b_{qlim}	Minimum semi-width of the platform installation gauge	m	1.025
b_r	Semi-width of the reference vehicle	m	1.026
b_{r1}	Semi-width of reference vehicle No. 1	m	1.027
b_{r2}	Semi-width of reference vehicle No. 2	m	1.028
b_{rinf}	Semi-width of the reference infrastructure	m	1.029
b_{veh}	Semi-width of the vehicle	m	1.030
$b_{veh(1)}$	Semi-width of vehicle 1	m	1.031
$b_{veh(2)}$	Semi-width of vehicle 2	m	1.032
b_w	Semi-width of the pantograph head	m	1.033
c	Calculation constant		1.034
C	Roll centre		1.035
RP	Reference profile		1.036
d	Dimension over wheel flanges	m	1.037
dg_a	Geometric overthrow of the vehicle on the outside of the curve	m	1.038

Table 1 (continued)

Symbol	Designation	Unit	Symbol number
$dg_{a\max}$	Maximum geometric overthrow allowed on the outside of the curve	m	1.039
dg_{av}	Vertical geometric overthrow on the outside of the curve	m	1.040
dg_i	Geometric overthrow of the vehicle on the inside of the curve	m	1.041
$dg_{i\max}$	Maximum geometric overthrow allowed on the inside of the curve	m	1.042
dg_{iv}	Vertical geometric overthrow on the inside of the curve	m	1.043
D	Cant	m	1.044
D_0	Fixed cant value taken into account by agreement between the vehicle and the infrastructure with regard to the kinematic gauge	M	1.045
D_{eq}	Equivalent cant	M	1.046
$D_{L(1)}$	Structure limit cant	M	1.047
$D_{L(2)}$	Structure installation limit cant	M	1.048
$D_{\max}$	Maximum cant	M	1.049
$D_{\max 0}$	Standard maximum cant to allow for enlargement of the kinematic gauge	M	1.050
Dpl	Transverse displacement	M	1.051
Dpl_{akin}	Transverse displacement towards the outside of the curve, taken into account for the kinematic gauge	m	1.052
Dpl_{adyn}	Transverse displacement towards the outside of the curve, taken into account for the dynamic gauge	m	1.053
Dpl_{ast}	Transverse displacement towards the outside of the curve, taken into account for the static gauge	m	1.054
Dpl_{kin}	Transverse displacement taken into account for the kinematic gauge	m	1.055
Dpl_{dyn}	Transverse displacement taken into account for the dynamic gauge	m	1.056
$Dpl_{dyn(A)}$	Transverse displacement of the vehicle A taken into account for the dynamic gauge	m	1.057
$Dpl_{dyn(B)}$	Transverse displacement of the vehicle B taken into account for the dynamic gauge	m	1.058
Dpl_{ikin}	Transverse displacement towards the inside of the curve, taken into account for the kinematic gauge	m	1.059
Dpl_{idyn}	Transverse displacement towards the inside of the curve, taken into account for the dynamic gauge	m	1.060

Table 1 (continued)

Symbol	Designation	Unit	Symbol number
Dpl_{ist}	Transverse displacement towards the inside of the curve, taken into account for the static gauge	m	1.061
Dpl_{st}	Transverse displacement taken into account for the static gauge	m	1.062
D_{add}	Additional cant	m	1.063
D_{th}	Theoretical equilibrium cant	m	1.064
e_a	Vertical reduction on the outside of the curve	m	1.065
e_i	Vertical reduction on the inside of the curve	m	1.066
e_p	Offset of the pantograph due to the vehicle characteristics	m	1.067
e_{po}	Offset of the pantograph at the upper verification point	m	1.068
e_{por}	Offset of the reference vehicle roof-mounted pantograph at the upper verification point	m	1.069
e_{pr}	Offset of the pantograph due to the reference vehicle characteristics	m	1.070
e_{pu}	Offset of the pantograph at the lower verification point	m	1.071
e_{pur}	Offset of the reference vehicle roof-mounted pantograph at the lower verification point	m	1.072
e_v	Lowering of track components	m	1.073
E	Transverse reduction relative to the reference profile	m	1.074
E_a	Transverse reduction relative the reference profile for cross-sections beyond the axles or beyond the bogie centres	m	1.075
E_i	Transverse reduction relative the reference profile for cross-sections between the axles or between the bogie centres	m	1.076
E_{fra}	Width to be cleared for the projection of collector shoes on the outside of a curve	m	1.077
E_{fri}	Width to be cleared for the projection of collector shoes on the inside of a curve	m	1.078
f_s	Raising of the contact wire	m	1.079
f_{so}	Raising of the contact wire at the lowest temperature, measured in relation to its position for the mean temperature	m	1.080
f_v	Contact wire sag. Initial sag including the sag between the hangers		1.081

Table 1 (continued)

Symbol	Designation	Unit	Symbol number
f_w	Contact wire sag at the highest temperature, measured in relation to its position for the mean temperature		1.082
f_{wa}	Wear of the head		1.083
f_{ws}	Displacement caused by the head roll		1.084
F	Fixed value taken into account in the additional overthrows	m	1.085
g	Acceleration due to gravity	m/s ²	1.086
G	Centre of gravity of the body		1.087
h	Height in relation to the running surface	m	1.088
h'_o	Maximum verification height of the pantograph gauge in a raised position	m	1.089
h'_u	Minimum verification height of the pantograph gauge in a raised position	m	1.090
h_c	Roll centre height	m	1.091
h_{c0}	Value of h_c used for the agreement between the vehicle and the infrastructure	m	1.092
h_{RP}	Height of the reference profile	m	1.093
h_{eff}	Effective height of the raised pantograph	m	1.094
$h_{eff\ elec}$	Effective height of the raised pantograph plus the electrical insulation	m	1.095
h_f	Height of the contact wire	m	1.096
h_{max}	Maximum height available for the infrastructure below the lower horizontal line of the reference profile	m	1.097
h_{min}	Height of the lower horizontal line of the reference profile	m	1.098
$h_{min(1)}$	Height of the lower horizontal line of the special reference profile of the lower parts for vehicles having to pass over marshalling humps and activated rail brakes	m	1.099
$h_{min(2)}$	Height of the lower horizontal line of the special reference profile of the lower parts for vehicles having to pass over marshalling humps and disengaged rail brakes	m	1.100
$h_{min\ RP}$	Height of the bottom corner of the reference profile	m	1.101
h_{ec}	Height of the platform edge coping	m	1.102

Table 1 (continued)

Symbol	Designation	Unit	Symbol number
h_q	Height of the platforms	m	1.103
h_t	Installation height of the lower pantograph joint in relation to the running surface	m	1.104
$h_{u\min}$	Minimum height specified for the vertical geometric displacements of the vehicle above the reference profile as a function of the vertical curve of the track	m	1.105
h_{veh}	Height of the vehicle	m	1.106
I	Cant deficiency	m	1.107
I'_c	Intermediate cant deficiency value between 0 and I_c	m	1.108
I'_p	Intermediate cant deficiency value taken into account for tilting body vehicles	m	1.109
I_c	Maximum cant deficiency used by the infrastructure manager for his routes	m	1.110
I_{eq}	Equivalent cant deficiency	m	1.111
$I_{L(1)}$	Structure limit cant deficiency	m	1.112
$I_{L(2)}$	Structure installation limit cant deficiency	m	1.113
$I_{\max}$	Maximum cant deficiency	m	1.114
$I_{\max 0}$	Standard maximum cant deficiency to take into account the suspension displacements with regard to the kinematic gauge	m	1.115
I_0	Fixed cant deficiency value taken into account by agreement between the vehicle and the infrastructure with regard to the kinematic gauge	m	1.116
I_p	Cant deficiency of tilting body vehicles	m	1.117
I_{add}	Additional cant deficiency	m	1.118
j	Minimum vertical reference clearances at the level of the side bearers	m	1.119
j'_a	Additional transverse clearances, towards the outside of the curve, relative to those of the reference vehicle	m	1.120
j'_i	Additional transverse clearances, towards the inside of the curve, relative to those of the reference vehicle	m	1.121
J	Actual vertical clearance at the level of the side bearers	m	1.122
k	Security coefficient to take into account track irregularities		1.123
K	Quasi-static roll coefficient taken into account by the infrastructure	m	1.124

Table 1 (continued)

Symbol	Designation	Unit	Symbol number
K'	Quasi-static roll coefficient taken into account for the pantograph reference profile		1.125
l	Track gauge, distance between the rail running edges	m	1.126
l_b	Width of tyre	m	1.127
l_{cr}	Position of the check rail in relation to the rail running edge	m	1.128
l_N	Nominal track gauge	m	1.129
l_{max}	Maximum track gauge	m	1.130
l_{act}	Actual track gauge	m	1.131
L_{dR1}	Developed length of radius R_1	m	1.132
l_{fl}	Width of the flangeway in relation to the rail running edge	m	1.133
L	Standard distance between the centrelines of the rails of the same track	m	1.134
$M_{(1)}$	Mandatory allowance	m	1.135
$M_{(1)kin}$	Mandatory allowance with regard to the kinematic gauge	m	1.136
$M_{(1)d}$	Part of the mandatory allowance $M_{(1)}$ due to the loading dissymmetry and the suspension adjustment	m	1.137
$M_{(1)dyn}$	Mandatory allowance with regard to the dynamic gauge	m	1.138
$M_{(1)osc}$	Part of the mandatory allowance $M_{(1)}$ due to the transverse oscillations of the vehicle with regard to the kinematic gauge	m	1.139
$M_{(1)st}$	Mandatory allowance with regard to the static gauge	m	1.140
$M_{(2)}$	Infrastructure maintenance allowance	m	1.141
$M_{(2)kin}$	Usable allowance with regard to the kinematic gauge	m	1.142
$M_{(2)D_{kin}}$	Part of the usable allowance $M_{(2)}$ due to the crosslevel errors T_D with regard to the kinematic gauge	m	1.143
$M_{(2)D_{dyn}}$	Part of the usable allowance $M_{(2)}$ due to the crosslevel errors T_D with regard to the dynamic gauge	m	1.144
$M_{(2)dyn}$	Usable allowance $M_{(2)}$ with regard to the dynamic gauge	m	1.145

Table 1 (continued)

Symbol	Designation	Unit	Symbol number
$M_{(2)st}$	Usable allowance with regard to the static gauge	m	1.146
$M_{(2)track}$	Part of the usable allowance $M_{(2)}$ due to the transverse displacement of the track	m	1.147
$M_{(3)}$	Additional infrastructure allowance	m	1.148
M_{fb}	Vertical allowance for the passage onto ferries	m	1.149
M_i	Electrical insulation allowance	m	1.150
$M_{osc(1)}$	Allowance for the dynamic roll due to the oscillations of vehicle No. 1	m	1.151
$M_{osc(2)}$	Allowance for the dynamic roll due to the oscillations of vehicle No. 2	m	1.152
M_v	Reserve vertical allowance	m	1.153
$M_{v(1)}$	Mandatory vertical allowance	m	1.154
$M_{v(2)}$	Maintenance vertical allowance	m	1.155
$M_{v(3)}$	Additional vertical allowance	m	1.156
n	Distance from the section under consideration to the adjacent end axle or to the closest pivot	m	1.157
n_a	n for the sections outside the axles or bogie centres	m	1.158
n_{ar}	n_a of the reference vehicle	m	1.159
n_i	n for the sections between the axles or bogie centres	m	1.160
n_{ir}	n_i of the reference vehicle	m	1.161
n_r	Distance from the section under consideration to the adjacent end axle or to the closest pivot of the reference vehicle	m	1.162
p	Bogie wheelbase	m	1.163
P_o	Reduction at the upper verification point of the pantographs	m	1.164
P_{oa}	Reduction at the upper verification point of the pantographs beyond the bogie centres	m	1.165
P_{oi}	Reduction at the upper verification point of the pantographs between the bogie centres	m	1.166
P_{fl}	Depth of the flangeway necessary to allow passage of the wheel flange	m	1.167
p_r	Reference vehicle bogie wheelbase	m	1.168
P_u	Reduction at the lower verification point of the pantographs	m	1.169

Table 1 (continued)

Symbol	Designation	Unit	Symbol number
P_{ua}	Reduction at the lower verification point of the pantographs beyond the bogie centres	m	1.170
P_{ui}	Reduction at the lower verification point of the pantographs between the bogie centres	m	1.171
q	Transverse clearance between wheelset and bogie frame, or wheelset and body for vehicles not fitted with bogies	m	1.172
q_r	Transverse clearance between wheelset and bogie frame, or wheelset of the reference vehicle	m	1.173
qs_a	Displacement due to the quasi-static roll taken into account by the infrastructure outside the reference profile on the outside of the curve	m	1.174
qs_i	Displacement due to the quasi-static roll taken into account by the infrastructure outside the reference profile on the inside of the curve	m	1.175
Q	Displacement due to the complete quasi-static roll	m	1.176
r	Reserve	m	1.177
R	Horizontal curve radius	m	1.178
R_1	Different curve radii used in junction work	m	1.179
R_2	Different curve radii used in junction work	m	1.180
R_c	Critical curve radius	m	1.181
R_{min}	Minimum curve radius	m	1.182
R_p	Radius corresponding to the maximum roll of a tilting body vehicle	m	1.183
R_{th}	Theoretical curve radius of junction work	m	1.184
R_v	Vertical curve radius	m	1.185
R_{vmin}	Minimum vertical curve radius	m	1.186
s	Flexibility coefficient		1.187
s_0	Flexibility coefficient taken into account in the agreement between the vehicle and the infrastructure		1.188
s'_0	Flexibility coefficient taken into account in the agreement between the vehicle and the infrastructure for the pantograph gauge		1.189
s_{lim}	Limit value of the flexibility coefficient		1.190
s_r	Flexibility coefficient of the reference vehicle		1.191

Table 1 (continued)

Symbol	Designation	Unit	Symbol number
S	Allowed additional overthrow	m	1.192
S_0	Standard value of additional overthrow linked to the reference profile	m	1.193
S'_0	Standard value of additional overthrow linked to the pantograph reference profile	m	1.194
S'_a	Allowed additional overthrow on the outside of the curve for pantographs	m	1.195
S'_i	Allowed additional overthrow on the inside of the curve for pantographs	m	1.196
S_a	Allowed additional overthrow on the outside of the curve	m	1.197
$S_{a_{kin}}$	Allowed additional overthrow on the outside of the curve with regard to the kinematic gauge	m	1.198
$S_{a_{dyn}}$	Allowed additional overthrow on the outside of the curve with regard to the dynamic gauge	m	1.199
$S_{a_{st}}$	Allowed additional overthrow on the outside of the curve with regard to the static gauge	m	1.200
S_{kin}	Allowed additional overthrow with regard to the kinematic gauge	m	1.201
S_{dyn}	Allowed additional overthrow with regard to the dynamic gauge	m	1.202
s_{eq}	Equivalent value of the flexibility coefficient		1.203
S_i	Allowed additional overthrow on the inside of the curve	m	1.204
$S_{i_{kin}}$	Allowed additional overthrow on the inside of the curve with regard to the kinematic gauge	m	1.205
$S_{i_{dyn}}$	Allowed additional overthrow on the inside of the curve with regard to the dynamic gauge	m	1.206
$S_{i_{st}}$	Allowed additional overthrow on the inside of the curve with regard to the static gauge	m	1.207
S_{st}	Allowed additional overthrow with regard to the static gauge	m	1.208
t	Pantograph flexibility coefficient	m	1.209
t_r	Reference vehicle pantograph flexibility coefficient	m	1.210
T_b	Construction tolerance of the vehicle in the transverse direction	m	1.211
T_{load}	Angle of dissymmetry, considered in η_{or} for poor load distribution	°	1.212
T_D	Track crosslevel errors between two maintenance periods	m	1.213
T_N	Track vertical tolerance	m	1.214

Table 1 (continued)

Symbol	Designation	Unit	Symbol number
T_{osc}	Crosslevel error selected for calculation of oscillations caused by track irregularities	m	1.215
T_q	Installation tolerance of the platforms	m	1.216
T_{susp}	Angle of dissymmetry, considered in η_{or} for poor suspension adjustment	°	1.217
T_{track}	Transverse displacement of the track between two periods of maintenance	m	1.218
v	Vehicle speed	m/s	1.219
V	Vehicle speed	km/h	1.220
V'_c	Intermediate value of the standard train speed	km/h	1.221
V'_p	Intermediate value of the tilting train speed	km/h	1.222
VF	Fixed value	m	1.223
$VF_{o(I_0)}$	Fixed value considered at the upper verification point of the pantographs for a cant deficiency I_0	m	1.224
$VF_{o(I_{max})}$	Fixed value considered at the upper verification point of the pantographs for a cant deficiency I_{max}	m	1.225
$VF_{u(I_0)}$	Fixed value considered at the lower verification point of the pantographs for a cant deficiency I_0	m	1.226
$VF_{u(I_{max})}$	Fixed value considered at the lower verification point of the pantographs for a cant deficiency I_{max}	m	1.227
w	Transverse clearance between bogie and body	m	1.228
$w_{(R)}$	Transverse clearance between bogie and body varying as a function of the track curve radius	m	1.229
$w_{a(R)}$	Transverse clearance between bogie and body towards the outside of the curve varying as a function of the track curve radius	m	1.230
$w_{i(R)}$	Transverse clearance between bogie and body towards the inside of the curve varying as a function of the track curve radius	m	1.231
w_r	Transverse clearance between bogie and body of the reference vehicle	m	1.232
x	Distance taken into account from the point of origin O for the calculation of e_v	m	1.233
z	Part of the quasi-static roll taken into account by the vehicle	m	1.234
z'	Difference between the transverse roll based on the calculation and the actual roll of the upper verification point of the pantograph	m	1.235

Table 1 (continued)

Symbol	Designation	Unit	Symbol number
z''	Difference between the transverse roll based on the calculation and the actual roll of the lower verification point of the pantograph	m	1.236
z_0	Fixed value available to the vehicle on the outside of the static reference profile to allow quasi-static roll of the vehicle	m	1.237
z_{kin}	Quasi-static roll of the vehicle with regard to the kinematic gauge	m	1.238
z_{dyn}	Quasi-static roll of the vehicle with regard to the dynamic gauge	m	1.239
z_{pkin}	Quasi-static roll of the tilting body vehicles with regard to the kinematic gauge	m	1.240
z_{pdyn}	Quasi-static roll of the tilting body vehicles with regard to the dynamic gauge	m	1.241
α	Additional angle of roll of the body due to the clearance to the side bearers	°	1.242
α_{osc}	Angle corresponding to the value T_{osc} expressed in millimetres	°	1.243
α'	Angle of the inclined part of the pantograph head in relation to the horizontal	°	1.244
α''	Angle made by the gangway between the platform and the ferry	°	1.245
β	Crossing angle of turnouts	radian	1.246
γ	Centrifugal acceleration	m/s ²	1.247
γ_D	Centripetal acceleration due to the cant	m/s ²	1.248
γ_I	Centrifugal acceleration resulting from the cant deficiency	m/s ²	1.249
Δ_a	Fixed term corresponding to: $n_a(a + n_a) - \frac{p^2}{4}$	m ²	1.250
Δ_{bi}	Additional width on the inside of the curve	m	1.251
Δ_{ba}	Additional width on the outside of the curve	m	1.252
Δh_{dyn}	Vertical movement of the vehicle taken into account for the dynamic gauges	m	1.253
Δ_i	Fixed term corresponding to: $n_i(a + n_i) - \frac{p^2}{4}$	m ²	1.254
δ	Angle of roll of the canted track	°	1.255
δ_{qa}	Value for the distance to the platform on the outside of the curve in relation to the gauge for the structures in the inclined position of value δ	m	1.256
$\delta_{qa_{max}}$	Maximum value of δ_{qa}	m	1.257

Table 1 (continued)

Symbol	Designation	Unit	Symbol number
$\Sigma_{j_{st}}$	Denotes the various indices that can accompany the value Σ with regard to the static gauge	m	1.258
$\Sigma_{j_{kin}}$	Denotes the various indices that can accompany the value Σ with regard to the kinematic gauge	m	1.259
$\Sigma_{j_{dyn}}$	Denotes the various indices that can accompany the value Σ with regard to the dynamic gauge	m	1.260
$\Sigma_{1_{kin}}$	Sum of the limit verification values for the infrastructure with regard to the kinematic gauge	m	1.261
$\Sigma_{2_{kin}}$	Sum of the limit values of the infrastructure allowances with regard to the kinematic gauge	m	1.262
$\Sigma_{3_{kin}}$	Sum of the nominal values of the allowances taken into account by the infrastructure with regard to the kinematic gauge	m	1.263
$\Sigma_{3_{kin_a}}$	Value $\Sigma_{3_{kin}}$ taken into account on the outside of the curve	m	1.264
$\Sigma_{3_{kin_i}}$	Value $\Sigma_{3_{kin}}$ taken into account on the inside of the curve	m	1.265
$\Sigma'_{1_{kin}}$	Value $\Sigma_{1_{kin}}$ taken into account for verification of the structures	m	1.266
$\Sigma''_{1_{kin}}$	Minimum value of $\Sigma'_{1_{kin}}$	m	1.267
$\Sigma'_{2_{kin}}$	Value $\Sigma_{2_{kin}}$ taken into account for installation of the structures	m	1.268
$\Sigma''_{2_{kin}}$	Minimum value of $\Sigma'_{2_{kin}}$	m	1.269
$\Sigma_{1_{kin(v)}}$	Sum of the limit verification values for the infrastructure with regard to the kinematic gauge in the vertical direction	m	1.270
$\Sigma_{2_{kin(v)i}}$	Sum of the limit values of the infrastructure allowances with regard to the kinematic gauge in the vertical direction on the inside of the curve	m	1.271
$\Sigma_{2_{kin(v)a}}$	Sum of the limit values of the infrastructure allowances with regard to the kinematic gauge in the vertical direction on the outside of the curve	m	1.272
$\Sigma_{3_{kin(v)i}}$	Sum of the nominal values of the infrastructure allowances with regard to the kinematic gauge in the vertical direction on the inside of the curve	m	1.273
$\Sigma_{3_{kin(v)a}}$	Sum of the nominal values of the infrastructure allowances with regard to the kinematic gauge in the vertical direction on the outside of the curve	m	1.274
$\Sigma_{1_{dyn}}$	Sum of the limit verification values for the infrastructure with regard to the dynamic gauge	m	1.275
$\Sigma_{2_{dyn}}$	Sum of the limit values of the infrastructure allowances with regard to the dynamic gauge	m	1.276

Table 1 (continued)

Symbol	Designation	Unit	Symbol number
$\Sigma_{3_{\text{dyn}}}$	Sum of the nominal values of the infrastructure allowances with regard to the dynamic gauge	m	1.277
Σ_v	Sum of the values of the allowances taken into account by the infrastructure in the vertical direction	m	1.278
λ	Angle made by the straight line joining the centre of gravity at the roll centre with the vertical	°	1.279
η	Angle of roll of the vehicle relative to the running surface	°	1.280
η_0	Angle of dissymmetry of a vehicle due to construction tolerances, to suspension adjustment and to unequal load distributions	°	1.281
η'_0	Angle of dissymmetry of a vehicle in which the clearance to the side bearers does not exceed j	°	1.282
η_{0r}	Reference angle η_0 taken into account in the agreement	°	1.283
θ	Angle resulting from the suspension adjustment tolerances	radian	1.284
θ_r	Angle resulting from the suspension adjustment tolerances of the reference vehicle	radian	1.285
τ	Pantograph construction and installation tolerance	m	1.286
τ_r	Reference vehicle pantograph construction and installation tolerance	m	1.287

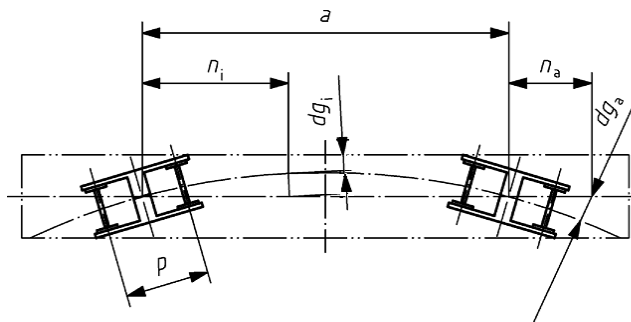
5 Specific considerations for determination of parameters

5.1 Geometric overthrow

5.1.1 Geometric overthrow between the vehicle body

To determine the geometric overthrow, the vehicle is considered to be ideally located with no clearance, in the median position on the track.

If a vehicle is located on a curved track, the geometric effect generates a transverse overthrow " dg_i " towards the inside of the curve for the parts between the bogie centres or between the wheelsets and a transverse overthrow " dg_a " towards the outside of the curve for the parts in the overhang (see Figure 8).



Key

a	distance between the end axles or between the bogie centres
n_a	longitudinal position of the section considered outside the wheelsets or bogie centres
n_i	longitudinal position of the section considered between the wheelsets or between the bogie centres
dg_a	geometric overthrow at the section position n_a
dg_i	geometric overthrow at the section position n_i
p	distance between the end axles of the bogie

Figure 8 — Geometric overthrow of the vehicle on a curved track

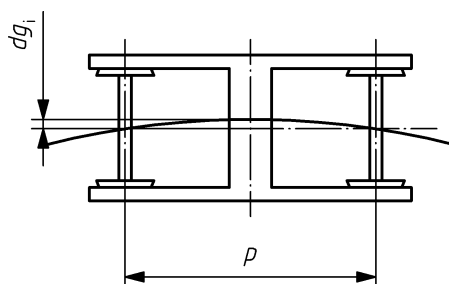
$$dg_a = \frac{an_a + n_a^2}{2R} \quad (2)$$

$$dg_i = \frac{an_i - n_i^2}{2R} \quad (3)$$

NOTE It should be noted that these formulae are slightly simplified, but the error is less than $\frac{n^2(a+n)^2}{8R^3}$, which is negligible taking into account the very high value of R^3 .

5.1.2 Additional geometric overthrow due to the bogies

The bogies produce an additional geometric overthrow " dg_i " towards the centre of the curve (see Figure 9).



Key

dg_i geometric overthrow at the bogie centre

p distance between the end axles of the bogie

Figure 9 — Geometric overthrow of the bogie on a curved track

$$dg_i = \frac{p^2}{8R} \quad (4)$$

Generally,

The geometric overthrow on the inside of the curve

$$dg_i = \frac{an_i - n_i^2 + \frac{p^2}{4}}{2R} \quad (5)$$

The geometric overthrow on the outside of the curve

$$dg_a = \frac{an_a + n_a^2 - \frac{p^2}{4}}{2R} \quad (6)$$

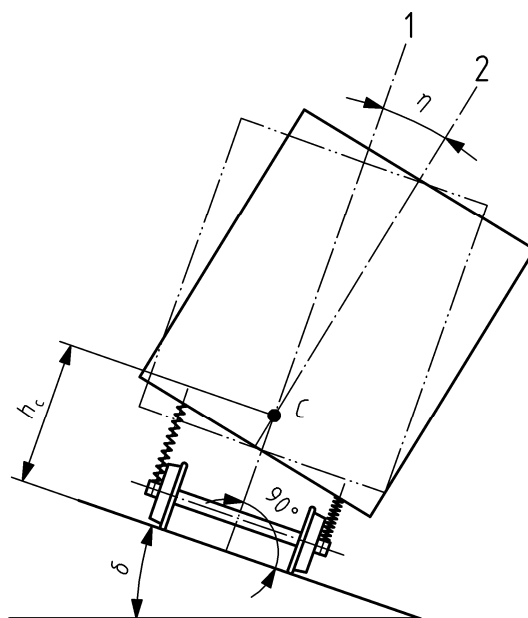
NOTE These same formulae may also be used in the vertical plane to determine " dg_{iv} " and " dg_{av} "

5.2 Flexibility coefficient

The flexibility coefficient

$$s = \frac{\eta}{\delta} \quad (7)$$

Figure 10 shows the roll due to the flexibility of the suspension.



Key

- 1 normal to the running surface
- 2 centreline of the inclined body under the effect of a cant
- C roll centre
- δ angle of roll of the canted track
- h_c roll centre height
- η angle of roll of the vehicle relative to the running surface

Figure 10 — Roll due to the flexibility of the suspension

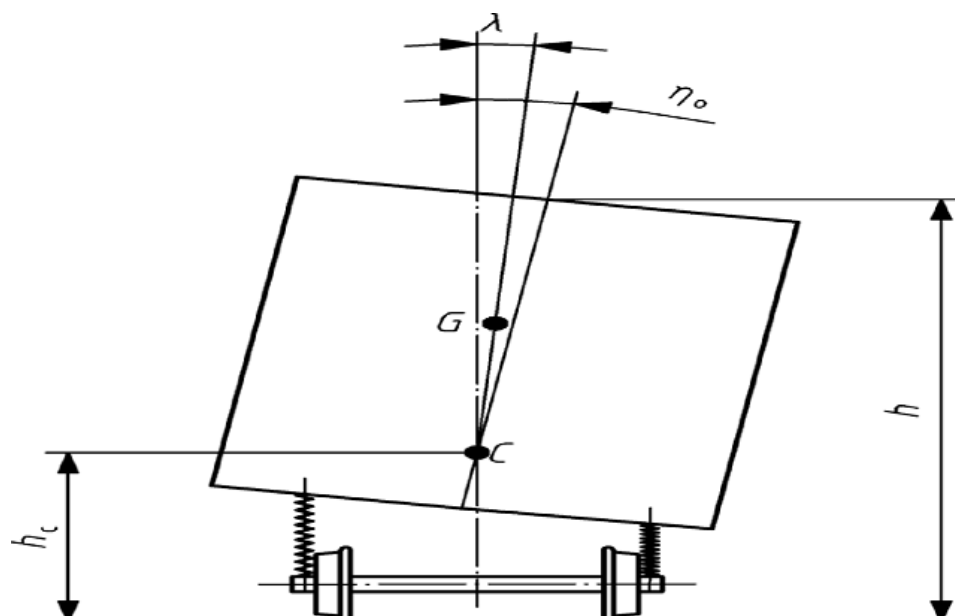
5.3 Dissymmetry

The dissymmetry taken into account for calculating the roll of the vehicle is:

$$\eta_0 = (1 + s)\lambda \quad (8)$$

The dissymmetry of the vehicle corresponds to angle λ and may be due to a structural imperfection, to poor adjustment of the suspension (set-up tolerances, etc.) and to an offset of the load (see Figure 11).

Angle λ is the angle made by the straight line joining the centre of gravity to the roll centre with the vertical.



Key

- C roll centre
- h height in relation to the running surface
- h_c roll centre height
- G centre of gravity of the body
- λ angle made by the straight line joining the centre of gravity to the roll centre with the vertical
- η_0 angle of dissymmetry due to construction tolerances, to suspension adjustment and to offset load distributions

Figure 11 — Illustration of dissymmetry

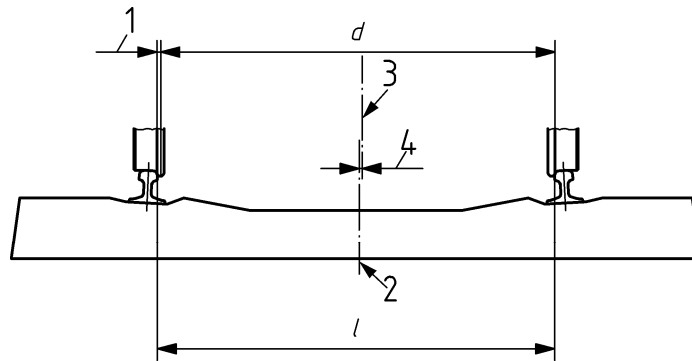
5.4 Clearance between the wheelsets and the track

Consider:

- the value " l " of the track gauge is measured between the rail running edges 14 mm below the running surface and the value " d " of the dimension over wheel flanges at the limit of wear is measured 10 mm below the wheel tread (see Figure 12).

The values, d and l may vary from one network to another.

The values d , l_N , $l_{\max}$ relative to each case under study are listed in the catalogue of gauges standardized in Annex B, Annex C, Annex D and Annex E.



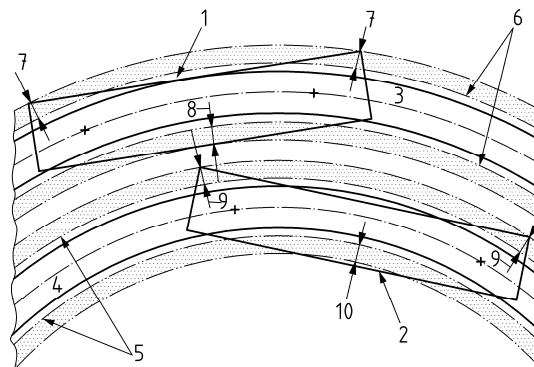
Key

- 1 clearance between the wheelset and the track
- 2 track centreline
- 3 centreline of the wheelset
- 4 transverse displacement of the wheelset in relation to the track centreline $\frac{l-d}{2}$
- d dimension over wheel flanges
- l track gauge, distance between the rail running edges

Figure 12 — Relative position between the wheelset and the track

5.5 Additional overthrow

Figure 13 shows the space reserved for additional overthrows S_i and S_a in relation to the reference profile.



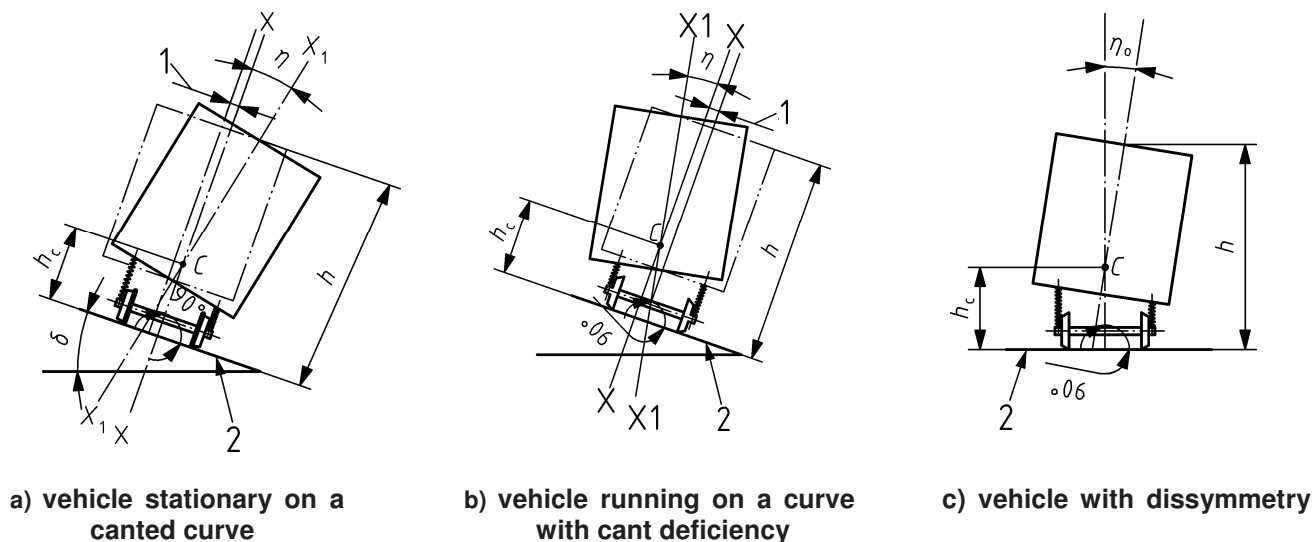
Key

- 1 reference vehicle running on the outer curved track
- 2 reference vehicle running on the inner curved track
- 3 outer curved track
- 4 inner curved track
- 5 reference profile of the inner curved track
- 6 reference profile of the outer curved track
- 7 additional overthrow " S_a " towards the outside of the outer curved track
- 8 additional overthrow " S_a " towards the inside of the outer curved track
- 9 additional overthrow " S_a " towards the outside of the inner curved track
- 10 additional overthrow " S_a " towards the inside of the inner curved track

Figure 13 — Additional overthrows in a curve

5.6 Roll centre

The transverse displacement of the body makes it possible to determine a centreline XX' . When the body rolls, the centreline XX' takes a position $X_1 X'_1$. The roll centre C is located at the intersection of centrelines XX' and $X_1 X'_1$ and its height h_c in relation to the running surface is referred to as the height of the roll centre. The position of the roll centre may vary as a function of the load (see Figure 14).



Key

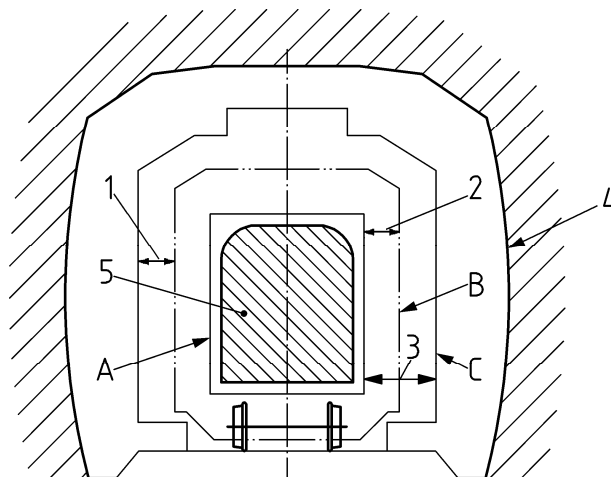
- 1 transverse displacement of the body
- 2 running surface
- C roll centre

Figure 14 — Roll of a vehicle around its roll centre

6 Gauges and gauging methods

6.1 General

A gauge is an agreement for the division of responsibilities between the vehicle and the infrastructure (see Figure 15).



Key

- A maximum construction gauge for the vehicle
- B reference profile
- C structure gauge
- 1 widenings comprising " $S, q_s, z_0, M1, M2, M3$ " established for the infrastructure
- 2 reductions " E_i or E_a " established for the vehicle
- 3 sum of the vehicle displacements and of the phenomena interacting with the infrastructure
- 4 structures
- 5 vehicle

Figure 15 — General illustration of the gauges

The basic elements required to establish an agreement are:

- a reference profile;
- one or more reference vehicles;
- distribution of responsibilities to take into account the phenomena between the infrastructure and the vehicle;
- the gauging rules for the infrastructure and for the vehicle;
- the allowed additional overthrows " S " for the vehicle outside the reference profile.

Each agreement specifies that:

For the vehicle, the maximum construction gauge is obtained by reducing the reference profile by a value

$$E = D_{pl} - S, \quad (9)$$

in the knowledge that the vehicle undergoes displacements " D_{pl} " and that the infrastructure authorizes additional overthrows " S " outside the reference profile.

For the infrastructure, the structure limit gauge is obtained by adding the additional overthrows " S " and taking into account phenomena not included in the reference profile. In order to simplify matters, the infrastructure may also decide to apply a **uniform** structure installation **gauge**.

The three types of agreement generally applied are commonly referred to as "**static gauge**", "**kinematic gauge**" and "**dynamic gauge**".

6.1.1 Static gauge

For the "**static gauge**", the infrastructure takes into account fixed allowances to cover certain dynamic displacements of the vehicle. The use of this type of gauge is restricted to vehicles in which the flexibility of the suspension is limited.

The static gauging method only applies to vehicles in which the quasi-static roll " z_{kin} " is not greater than the value " z_0 " specified below, the value of which is given in Annex B.

Thus, for the vehicle:

- the semi-width " b_{veh} " of the vehicle under consideration is calculated on the basis of a static reference profile " b_{RPst} " by adding the corresponding static additional overthrow " S_{st} " and subtracting the static displacements " Dpl_{st} "

$$b_{veh} \leq b_{RPst} + S_{st} - Dpl_{st} \quad (10)$$

- the vehicle takes no account of the dynamic uplift of the suspension.

For the infrastructure:

- the enlargement for dynamic uplift and drop shall be taken into account by respectively adding to or subtracting from the height of the static reference profile.

The semi-width " b_{inf} " is defined by taking into account the fixed allowances established by the infrastructure.

These fixed allowances shall be adequate to cover all the dynamic displacements of the vehicle not included inside the static reference profile.

Considering that $qs_i = Q_{D>D_0}$ and $qs_a = Q_{I>I_0}$, it is possible to verify that the allowances are adequate by applying the following formula:

$$b_{inf} \geq b_{RPst} + S_{st} + z_0 + [qs_i \text{ or } qs_a] + M_{(1)d} + M_{(1)osc} + M_{(2)track} + M_{(2)D} + M_{(3)} \quad (11)$$

- the infrastructure specifies a vertical allowance to take account of the dynamic uplift of the suspension.

6.1.2 Kinematic gauge

For the "**kinematic gauge**", the infrastructure takes into account the dynamic displacements of the vehicle not exceeding certain values specified in the agreement. Any exceeding of the standard values is borne by the vehicle.

Quasi-static roll is partially taken into account in the displacement " Dpl_{kin} " inside the reference profile.

The value " z_{kin} " considered for this purpose inside the reference profile varies as a function of the vehicle suspension flexibility and characteristics under consideration. The calculation is based on a fixed cant or cant deficiency D_0 or I_0 taken into account by the vehicle.

As far as it is concerned, the infrastructure clears the complementary quasi-static roll qs_i or qs_a on the basis of the parameters of the reference vehicles included in the agreement and in the local track characteristics.

Consequently, the kinematic gauging method is applicable to every vehicle irrespective of its suspension flexibility.

Thus

- the semi-width " b_{veh} " of the vehicle under consideration is calculated on the basis of a kinematic reference profile " b_{RPkin} " by adding the corresponding kinematic additional overthrow " S_{kin} " and by subtracting the kinematic displacements " Dpl_{kin} ";

$$b_{\text{veh}} \leq b_{\text{RPkin}} + S_{\text{kin}} - Dpl_{\text{kin}} \quad (12)$$

- the semi-width " b_{inf} " of the corresponding infrastructure is calculated on the basis of the reference profile " b_{RPkin} " by adding the kinematic additional overthrow " S_{kin} ", the quasi-static roll qs_i or qs_a , the additional dynamic roll " $M_{(1)\text{kin}}$ ", the usable maintenance allowances " $M_{(2)\text{kin}}$ " and a possible reserve " $M_{(3)}$ ".

$$b_{\text{inf}} \geq b_{\text{RPkin}} + S_{\text{kin}} + [qs_i \text{ or } qs_a] + M_{(1)\text{d}} + M_{(1)\text{osc}} + M_{\text{track}} + M_{(2)\text{D}} + M_{(3)} \quad (13)$$

6.1.3 Dynamic gauge

For the "**dynamic gauge**", the infrastructure does not take into account the vehicle displacements. All the displacements are managed by the vehicle on the basis of a track quality defined in the agreement.

In the dynamic gauging method, all the displacements " Dpl_{dyn} " of the vehicle are determined by considering an equivalent cant " $D_{\text{eq}} \geq D_{\text{max}} + D_{\text{sup}}$ " or a cant deficiency " $I_{\text{eq}} \geq I_{\text{max}} + I_{\text{sup}}$ " and are taken into account inside the dynamic reference profile.

The values of D_{sup} and I_{sup} are calculated in order to include the effects of the oscillations " $M_{(1)\text{osc}}$ " and the dynamic part $s \frac{T_D}{L} (h - h_{c0})_{>0}$ of the crosslevel error " $M_{(2)\text{D}}$ " inside the reference profile.

The additional values D_{sup} and I_{sup} correspond to the sum " $T_{\text{osc}} + T_D$ " with the possibility of varying the values as a function of the infrastructure criteria according to the track quality, speed and according to whether it is a matter of cant or cant deficiency.

As far as it is concerned, the infrastructure takes into account the allowances $M_{(1)\text{d}}$ and $M_{(2)\text{dyn}}$ outside the dynamic reference profile.

Therefore, the dynamic gauging method is applicable to all vehicles and enables their width to be optimized depending on the flexibility of their suspensions.

Thus

- the semi-width " b_{veh} " of the vehicle under consideration is calculated on the basis of a dynamic reference profile " b_{RPdyn} " by adding the corresponding dynamic additional overthrow " S_{dyn} " and by subtracting the dynamic displacements " Dpl_{dyn} "

$$b_{\text{veh}} \leq b_{\text{RPdyn}} + S_{\text{dyn}} - Dpl_{\text{dyn}} \quad (14)$$

- the semi-width " b_{inf} " of the corresponding infrastructure is calculated on the basis of the reference profile " b_{RPdyn} " by adding the dynamic additional overthrow " S_{dyn} ", the allowance $M_{(1)\text{d}}$ to cover the dissymmetry η_0 , the allowance $M_{(2)\text{dyn}}$ covering the transverse displacement of the track $M_{(2)\text{track}}$ and the geometric part $h \frac{T_D}{L}$ of the crosslevel error $M_{(2)\text{D}}$ and a possible reserve $M_{(3)}$.

$$b_{\text{inf}} \geq b_{\text{RPdyn}} + S_{\text{dyn}} + M_{(1)\text{d}} + M_{(2)\text{dyn}} + M_{(3)} \quad (15)$$

6.1.4 Uniform structure gauge

The uniform structure gauge results from a numerical application officially comprising the maximum additional overthrows, the maximum allowed quasi-static effects and the infrastructure allowances.

The uniform structure gauge is a nominal gauge to which the infrastructure does not add any additional overthrow or quasi-static effect.

It is reserved solely for the infrastructure and the vehicle running on it shall be sized according to one of the static, kinematic or dynamic gauges.

Generally, uniform gauges have a greater allowance between the vehicle and the structures in the large radii and on a straight track. This explains why zones reserved for the installation of the platforms may be located inside uniform gauges.

6.1.5 Gauges and interoperability

Static, kinematic and dynamic gauges ensure various levels of interoperability for the vehicles on all the infrastructures that have cleared the gauges of the same name.

- the static gauge ensures interoperability of vehicles in which the roll due to the flexibility of the suspensions does not exceed a limit value specified in the agreement;
- the kinematic gauge ensures interoperability of all types of vehicles;
- the dynamic gauge ensures interoperability of vehicles on infrastructures that comply with the track quality specified in the agreement.

6.1.6 Illustration and comparison of static and kinematic gauges in the transverse direction

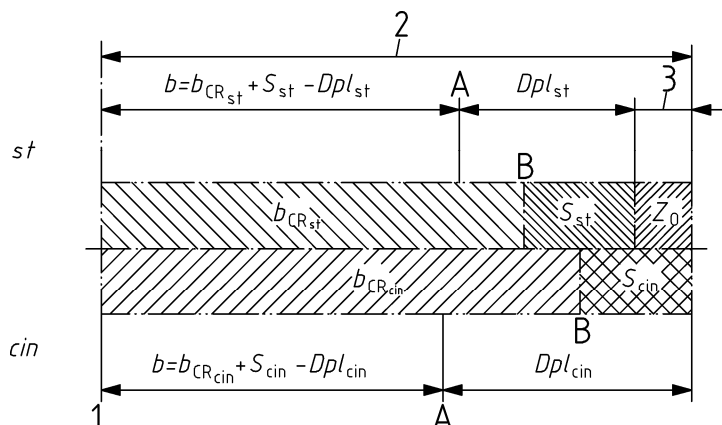
In spite of an equivalent composition of the constituents of a static gauge and a kinematic gauge of the same name, if the infrastructure allowances are limited, it is possible that they will not ensure that vehicles constructed to the kinematic gauge will be able to operate (see Figure 16 and Figure 17).

For networks wanting to ensure full compatibility of their infrastructure, this comparison of static and kinematic gauges makes it possible to define a structure installation limit gauge on the basis of an existing static gauge.

It shall be noted that the kinematic gauge applied by the infrastructure also allows the operation of vehicles constructed according to the static gauge.

The kinematic reference profile corresponding to the original static gauge is obtained by the following relationship:

$$b_{RP\text{ kin}} = b_{RP\text{ st}} + S_t - S_{\text{kin}} + z_0 \quad (16)$$



Key

- A maximum vehicle construction gauge
- B reference profile
- 1 track centreline
- 2 composition of constituents
- 3 zone "z₀" of the infrastructure, made available to the vehicle with regard to the static gauge

Figure 16 — Equivalence of the composition of constituents of static gauges and the corresponding kinematic gauges

The structure gauge allows interoperability to be achieved by including the roll qs_i or qs_a and the allowances as a function of the flexibility coefficient s_0 used for the kinematic gauge.

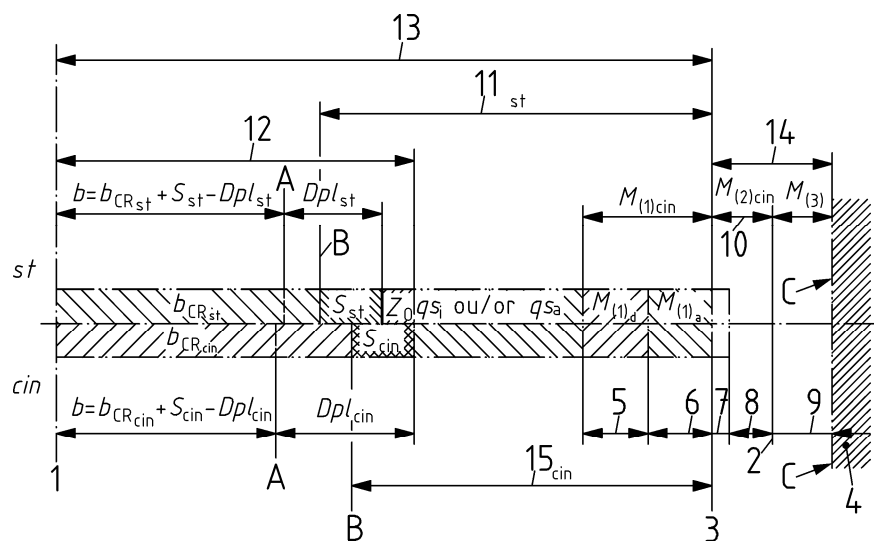
In the case of non-interoperable routes, it is recommended adopting the same principle, with the limit flexibility coefficient s_{lim} corresponding to the value z_0 .

The allowances $M_{(1)\text{ kin}}$, $M_{(2)\text{ kin}}$ and $M_{(3)}$ take into account various random phenomena that mean:

the infrastructure manager adopts the method of his choice:

- either, fixed values based on his experience, his operational and maintenance rules;
- or, a Gaussian probability and a security coefficient based on local running conditions;
- $\sum_{1\text{ kin}}$, the sum of the random elements taken into account for the limit verification;
- $\sum_{2\text{ kin}}$, the sum of the elements taken into account for the structure installation limit gauge;

- $\sum_{3\text{kin}}$, the sum of the elements taken into account for the structure installation nominal gauge;
- recommended values are given in the Annex to EN 15273-3.



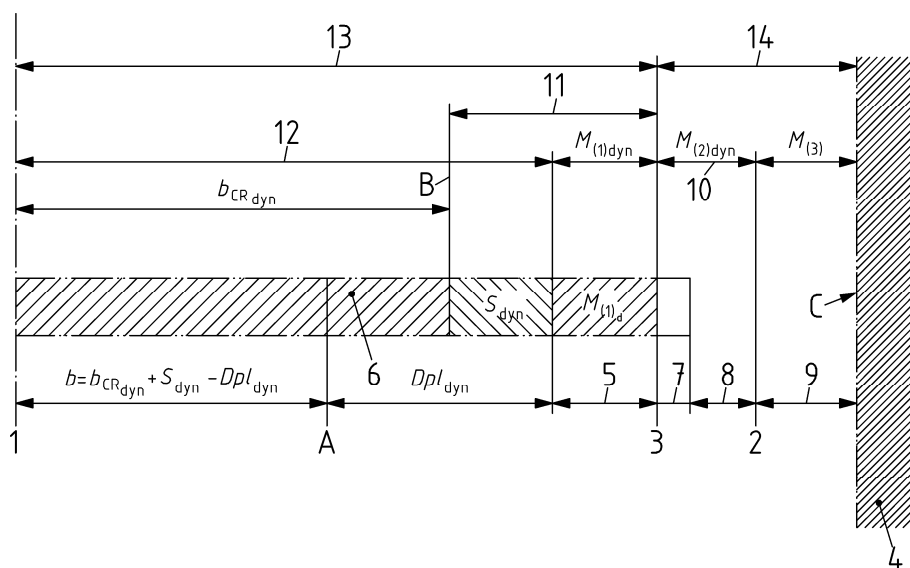
Key

- A maximum vehicle construction gauge
- B reference profile
- C structure gauge
- 1 track centreline
- 2 structure installation limit gauge
- 3 envelope of the reference vehicle without using the maintenance allowances
- 4 structure installation nominal gauge
- 5 mandatory allowance " $M_{(1)d}$ "
- 6 mandatory allowance " $M_{(1)osc}$ "
- 7 usable allowance " $M_{(2)kin}$ "
- 8 usable allowance " $M_{(2)track}$ "
- 9 reserve allowance $M_{(3)}$ (this reserve may contain the aerodynamic allowances)
- 10 usable allowance $M_{(2)kin}$ between the installation limit gauge and limit gauge
- 11 constituent determined by the infrastructure manager
- 12 constituent determined by the vehicle manager
- 13 structure limit gauge for a defined track quality and a given speed
- 14 infrastructure manager reserve

Figure 17 — Illustration and comparison of the static and kinematic gauges

6.1.7 Illustration of the dynamic gauge

Figure 18 illustrates the dynamic gauge.



Key

- A maximum vehicle construction gauge
- B reference profile
- C structure gauge
- 1 track centreline
- 2 structure installation limit gauge
- 3 envelope of the reference vehicle without using the maintenance allowances
- 4 structure installation nominal gauge
- 5 mandatory allowance " $M_{(1)d}$ "
- 6 full quasi-static roll Q and mandatory allowance " $M_{(1)osc}$ " in $b_{RP_{dyn}}$
- 7 usable allowance " $M_{(2)D_{dyn}}$ "
- 8 usable allowance " $M_{(2)track}$ "
- 9 reserve allowance $M_{(3)}$ (this reserve may contain the aerodynamic allowances)
- 10 usable allowance $M_{(2)kin}$ between the installation limit gauge and limit position
- 11 constituent determined by the infrastructure manager
- 12 constituent determined by the vehicle manager
- 13 structure limit gauge for a defined track quality and a given speed
- 14 mandatory allowance " $M_{(1)d}$ "

NOTE The same principle may be applied in the vertical direction.

Figure 18 — Illustration of the dynamic gauge

6.2 Other gauging methods

6.2.1 General

The following gauging methods do not use a reference profile nor a one-to-one agreement between the vehicle and the infrastructure. Therefore, they are not gauges.

These methods are reserved for vehicles dedicated to specific routes.

The **"dynamic gauge"** calculation formulae may be used for these applications.

6.3 Absolute gauging method

For the absolute gauging method, the vehicle relies on the position of the structures to define its own maximum construction gauge (see Figure 19).

The minimum value of the allowances to be specified in relation to the actual semi-width of the infrastructure corresponds to the values taken into account by the infrastructure with respect to the dynamic gauge.

The dynamic envelope of the vehicle under consideration is defined by a swept envelope as a function of the local running conditions, taking into account the corresponding dynamic displacements " Dpl_{dyn} ".

Thus

- the semi-width " b_{veh} " of the vehicle under consideration is calculated on the basis of the reference semi-width of the infrastructure " b_{rinf} " by subtracting the allowances taken into account by the infrastructure and the dynamic displacements " Dpl_{dyn} ";

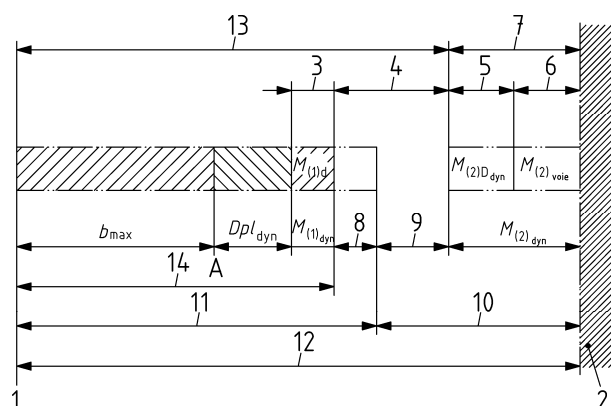
$$b_{veh} \leq b_{rinf} - Dpl_{dyn} - M_{(1)d} - M_{(2)dyn} - M_{(3)} \quad (17)$$

- the minimum semi-width " b_{inf} " allowed by the infrastructure is calculated on the basis of the reference semi-width " b_{rinf} " by subtracting the usable allowance " $M_{(2)dyn}$ " any a possible reserve $M_{(3)}$.

$$b_{inf} \geq b_{rinf} - M_{(2)dyn} - M_{(3)} \quad (18)$$

NOTE 1 If specified, the aerodynamic part of the allowance $M_{(3)}$ is not taken into account by the infrastructure in b_{inf} , it depends on the vehicle.

NOTE 2 In certain cases, the absolute gauging method may also be used for the pantographs.



Key

- A maximum vehicle construction gauge
- 1 track centreline
- 2 structures
- 3 mandatory allowance " $M_{(1)d}$ " for the dissymmetry
- 4 reserve allowance $M_{(3)}$
- 5 usable allowance " $M_{(2)D_{dyn}}$ " for crosslevel error
- 6 usable allowance " $M_{(2)track}$ " for track tolerances and wear
- 7 usable allowance $M_{(2)_{dyn}}$ for infrastructure maintenance
- 8 aerodynamic allowance
- 9 infrastructure manager reserve
- 10 constituents determined by the infrastructure manager
- 11 constituents determined by the vehicle manager
- 12 infrastructure reference semi-width b_{rinf}
- 13 structure limit gauge for a specified track quality
- 14 swept envelope

NOTE The same principle may be applied in the vertical direction.

Figure 19 — Illustration of the absolute gauging method

6.4 Comparative gauging method

In the comparative gauging method, the vehicle relies on an existing vehicle already running on a given route to define the maximum vehicle construction gauge of a new vehicle under consideration.

The comparative gauging method makes it possible to ensure that the envelope swept by a vehicle 1 is no bigger than that swept by a reference vehicle 2 already running on a specified route.

Thus

$$b_{veh(1)} \leq b_{veh(2)} + Dpl_{dyn(2)} - Dpl_{dyn(1)} \quad (19)$$

7 Elements involved in the determination of a gauge

This clause lists the elements to be taken into account to avoid any interference between the vehicle and the infrastructure and between the vehicles.

7.1 General

7.1.1 In the transverse direction

Table 2 gives the elements to be taken into account for the transverse direction.

Table 2 — Elements to be taken into account for the transverse direction

	Static		Kinematic		Dynamic	
	Vehicle	Infra	Vehicle	Infra	Vehicle	Infra
— the semi-width of the vehicle " b_{veh} " at the point under consideration	5.1.1		5.1.2		5.3	
— the transverse position of the structure " b_{inf} "		5.1.1.		5.1.2.		5.1.3.
— the track centres EA		EN 15273-3		EN 15273-3		EN 15273-3
— the vehicle construction tolerances	EN 15273-2		EN 15273-2		EN 15273-2	
— the geometric overthrow " dg_i or dg_a " of the point under consideration as a function of the track curvature	3.12		3.12		3.12	
— the effects of the transverse clearances between the body and bogie as a function of the curve radius $A \cdot w_{(R)}$	7.2.1.11		7.2.1.12		7.2.1.13	
— the effects of the transverse clearances between wheelset and bogie $A \cdot q$	7.2.1.11		7.2.1.12		7.2.1.13	
— the effects of the transverse clearances of the wheelsets on the track $A \left(\frac{l_{max} - d}{2} \right)$	7.2.1.11		7.2.1.12		7.2.1.13	
— the effect of track gauge widening $\frac{l_{actual} - l_N}{2}$		7.2.1.1.1		7.2.1.1.1		7.2.1.1.1
— the effect of roll " η_0 " due to vehicle dissymmetry		3.14	3.14	3.14	3.14	3.14

Table 2 (continued)

	Static		Kinematic		Dynamic	
	Vehicle	Infra	Vehicle	Infra	Vehicle	Infra
— the effects of the roll of tilting vehicles			7.2.1.14		7.2.1.14	
— the effect of the roll due the vertical clearance " J " at the position of the side bearers			7.2.1.4.2.1		7.2.1.4.2.2	
— the horizontal component of the vehicle roll due to the excess cant or cant deficiency " Q "		7.2.1.4.2	7.2.1.4.2.1	7.2.1.4.2.1	7.2.1.4.2.2	
— crosslevel error due to defects and tolerances " T_D "		7.2.1.4.2	7.2.1.4.2.1	7.2.1.4.2.1	7.2.1.4.2.2	7.2.1.4.2.2
— the transverse bending of the body	EN 15273-2		EN 15273-2		EN 15273-2	
— the infrastructure construction tolerances		EN 15273-3		EN 15273-3		EN 15273-3
— the dynamic roll " $M_{(1)osc}$ " due to oscillations generated by the irregularities of the track for a reference quality and speed		7.2.1.5		7.2.1.5	7.2.1.5	
— the transverse displacement of the track between two maintenance periods " T_{track} "		7.2.1.6		7.2.1.6		7.2.1.6

7.1.2 In the vertical direction

Table 3 gives the elements to be taken into account for the vertical direction.

Table 3 — Elements to be taken into account for the vertical direction

	Static		Kinematic		Dynamic	
	Vehicle	Infra	Vehicle	Infra	Vehicle	Infra
Geometric						
— the height of the point under consideration on the vehicle	EN 15273-2		EN 15273-2		EN 15273-2	
— the vertical position of the structure under consideration		EN 15273-3		EN 15273-3		EN 15273-3
— the vertical geometric overthrow " dg_{iv} or dg_{av} " of the point under consideration as a function of the track curvature	7.2.2.3	7.2.2.3	7.2.2.3	7.2.2.3	7.2.2.3	7.2.2.3
Tolerances						
— vehicle construction tolerances	EN 15273-2		EN 15273-2		EN 15273-2	
— tolerance on the adjustment of the suspension (air, ...)	EN 15273-2		EN 15273-2		EN 15273-2	
— tolerances on the positioning of the track " T_{track} "		EN 15273-3		EN 15273-3		EN 15273-3
— crosslevel error due to defects and tolerances " T_D "		7.2.2.2		7.2.2.2	7.2.2.2	7.2.2.2
— track vertical tolerance " T_N "		7.2.2.2		7.2.2.2		7.2.2.2
— tolerances on the installation of the structures		EN 15273-3		EN 15273-3		EN 15273-3
Wear down to the maintenance limits						
— wear of the wheels	EN 15273-2		EN 15273-2		EN 15273-2	
— wear of the rails		EN 15273-3		EN 15273-3		EN 15273-3
— wear of the axle boxes	EN 15273-2		EN 15273-2		EN 15273-2	