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Railway applications — Calculation of braking performance (stopping, slowing and stationary braking) —

Part 1: General algorithms utilizing mean value calculation

Applications ferroviaires — Calcul des performances de freinage (freinage d'arrêt, de ralentissement et d'immobilisation) —

Partie 1: Algorithmes généraux utilisant le calcul par la valeur moyenne

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 269, *Railway applications*.

A list of all parts in the ISO 20138 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

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Introduction

This document describes methodologies for calculation of braking performance, such as stopping distance, deceleration, power and energy for railway rolling stock. The calculations can be used at any stage of the assessment process (design, manufacture, testing, verification, investigation, etc.) of railway rolling stock.

The objective of this document is to enable the railway industry and operators to work with common calculation methods.

This document is published in two separate parts (ISO 20138-1 and ISO 20138-2), which will complement each other and can be used separately, depending on the requirements of the user.

The first part of the standard describes a common calculation method for railway applications applicable to all countries. It describes the general algorithms/formulae using mean value inputs to perform calculations of brake equipment and braking performance, in terms of stopping and slowing distances and safety for parking brake, for all types of trainsets and single vehicles. In addition, the algorithms provide a means of comparing the results of other braking performance calculation methods.

The second part of the standard details the step by step calculation methodology utilizing instantaneous values of brake force provided by each operational brake equipment type throughout the stopping/slowing time.

The two separate parts of the standard relate to each other but can be used separately, depending on the requirements of the user.

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Railway applications — Calculation of braking performance (stopping, slowing and stationary braking) —

Part 1: General algorithms utilizing mean value calculation

1 Scope

This document specifies methodologies for calculation of braking performance for railway rolling stock and is applicable to all countries.

This document describes the general algorithms/formulae using mean value inputs to perform calculations of brake equipment and braking performance in terms of stopping/slowing distances, stationary braking, power and energy for all types of rolling stock, either as single vehicles or train formations, with respect to the braking distance.

The calculations can be used at any stage of the assessment process (design, manufacture, testing, verification, investigation, etc.) of railway rolling stock. This document does not set out the specific acceptance criteria (pass/fail).

This document is not intended to be used as a design guide for selection of brake systems and does not specify performance requirements. This document does not provide a method to calculate the extension of stopping distances when the level of available adhesion is exceeded (wheel slide activity).

This document contains examples of the calculation of brake forces for different brake equipment types and calculation of stopping distance and stationary braking relevant to a single vehicle or a train.

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.

ISO 20138-2[1)], *Railway applications — Calculation of braking performance (stopping, slowing and stationary braking) — Part 2: General algorithms utilizing step by step calculation*

3 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
train
operational formation consisting of one or more units

1) Under preparation. Stage at the time of publication: ISO/DIS 20138-2:2018.

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3.2
trainset
fixed formation unit that can operate as a train

3.3
unit
element of the train formation which can be composed of one or several vehicle(s)

3.4
vehicle
individual element of a unit

EXAMPLE Locomotive, coach, wagon, driving coach.

3.5
retention force
force, which is greater or equal than the sum of external forces and downhill force due to gravity

3.6
brake force
retarding force
forces generated by a brake equipment type or external forces

Note 1 to entry: The dynamic mass (sum of static and rotating masses) is braked by brake forces.

Note 2 to entry: Retarding forces are stopping or decelerating a vehicle or unit.

Note 3 to entry: In some cases (e.g. magnetic track brake), the brake force is equal to the retarding force. In other cases, a differentiation in brake force and retarding force is needed, e.g. calculation of required adhesion.

4 Symbols

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

Table 1 — Symbols

Symbol	Definition	Unit
A_b	Contact area per brake block	m^2
A_c	Brake cylinder area	m^2
A_p	Contact area per brake pad	m^2
a	Defined level for the minimum output signal (typically 10 % or 5 %)	%
a_e	Equivalent deceleration	m/s^2
$a_{e,grad}$	Equivalent deceleration including the effect of gradient and inertia	m/s^2
$a_{e,grad_simple}$	Equivalent deceleration neglecting inertia	m^2
$a_{e,z}$	Equivalent deceleration acting during speed range, z	m/s^2
α	Angle of slope	°
b	Defined level for the maximum output signal (typically 95 % or 90 %)	%
C_1	Characteristic coefficient of the train independent of speed	N
C_2	Characteristic coefficient of the train proportional to the speed	N/(m/s)
C_3	Characteristic coefficient of aerodynamic resistance due to pressure drag and skin friction drag	$N/(m/s)^2$
D	Wheel diameter	m
F	Force	N
F_{AMg}	Attraction force of one magnet	N

[a] bar or kPa is also allowed; 1 bar = 10^5 Pa.

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