



# FINAL DRAFT

## International Standard

### ISO/FDIS 20138-1

## 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*

ISO/TC 269/SC 2

Secretariat: **AFNOR**

Voting begins on:  
**2025-09-26**

Voting terminates on:  
**2025-11-21**

RECIPIENTS OF THIS DRAFT ARE INVITED TO SUBMIT, WITH THEIR COMMENTS, NOTIFICATION OF ANY RELEVANT PATENT RIGHTS OF WHICH THEY ARE AWARE AND TO PROVIDE SUPPORTING DOCUMENTATION.

IN ADDITION TO THEIR EVALUATION AS BEING ACCEPTABLE FOR INDUSTRIAL, TECHNOLOGICAL, COMMERCIAL AND USER PURPOSES, DRAFT INTERNATIONAL STANDARDS MAY ON OCCASION HAVE TO BE CONSIDERED IN THE LIGHT OF THEIR POTENTIAL TO BECOME STANDARDS TO WHICH REFERENCE MAY BE MADE IN NATIONAL REGULATIONS.

iTeh Standards  
(<https://standards.iteh.ai>)  
Document Preview

ISO/FDIS 20138-1

<https://standards.iteh.ai/catalog/standards/iso/9372db98-a727-40d1-b1f9-a8f9dc0565eb/iso-fdis-20138-1>



**COPYRIGHT PROTECTED DOCUMENT**

© ISO 2025

All rights reserved. Unless otherwise specified, or required in the context of its implementation, no part of this publication may be reproduced or utilized otherwise in any form or by any means, electronic or mechanical, including photocopying, or posting on the internet or an intranet, without prior written permission. Permission can be requested from either ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office  
CP 401 • Ch. de Blandonnet 8  
CH-1214 Vernier, Geneva  
Phone: +41 22 749 01 11  
Email: [copyright@iso.org](mailto:copyright@iso.org)  
Website: [www.iso.org](http://www.iso.org)

Published in Switzerland

## Contents

Page

<b>Foreword</b>	<b>v</b>
<b>Introduction</b>	<b>vii</b>
<b>1 Scope</b>	<b>1</b>
<b>2 Normative references</b>	<b>1</b>
<b>3 Terms and definitions</b>	<b>1</b>
<b>4 Symbols</b>	<b>2</b>
<b>5 Stopping and slowing distances calculation</b>	<b>7</b>
5.1 General	7
5.2 Rail vehicle characteristics	9
5.2.1 Static mass, $m_{st}$	9
5.2.2 Equivalent rotating mass, $m_{rot}$	9
5.2.3 Dynamic mass, $m_{dyn}$	10
5.2.4 Wheel diameter, $D$	10
5.3 Wheel/rail adhesion dependent brake unit type characteristics	10
5.3.1 Basic brake cylinder	10
5.3.2 Tread brake	11
5.3.3 Tread brake unit	14
5.3.4 Disc brake	15
5.3.5 Electro-dynamic brake	17
5.3.6 Fluid retarder	17
5.4 Wheel/rail adhesion independent brake unit characteristics	18
5.4.1 Magnetic track brake	18
5.4.2 Linear eddy current brake	19
5.4.3 Force from train resistance	20
5.4.4 Aerodynamic brake	21
5.4.5 Wind force on the train, $F_{wind}$	21
5.5 Time characteristics	21
5.5.1 Declaration of brake subsystem time characteristics	21
5.5.2 Equivalent response time, $t_{a,e}$	21
5.6 Initial and operating characteristics	23
5.6.1 Forces on the slope	23
5.6.2 Downhill force due to gravity depending on the gradient, $F_D$	23
5.6.3 Blending	24
5.6.4 Value of the mean wheel/rail adhesion required for the braked wheelset, $\bar{\tau}_{ax}$	25
5.7 Stopping and slowing distance calculation based on mean values	25
5.7.1 Mean decelerating force with respect to the distance, $\bar{F}_{Dec}$	25
5.7.2 Equivalent braking deceleration, $a_{f,e}$ , based on decelerating force	25
5.7.3 Equivalent free running distance, $s_{a,e}$	26
5.7.4 Stopping and slowing distance on level track, $s$	26
5.7.5 Methods of calculating stopping and slowing distance on a gradient	26
5.8 Additional dynamic calculations	27
5.8.1 General	27
5.8.2 Braking energy	27
5.8.3 Maximum braking power of a brake subsystem, $P_{max,n}$	28
5.8.4 Maximum braking power of a brake unit, $P_{max,u,n}$	28
<b>6 Stationary braking</b>	<b>28</b>
6.1 General	28
6.2 Holding brake	28
6.3 Immobilization brake	28
6.4 Parking brake	29

6.5	Stationary brake calculation.....	29
6.5.1	General.....	29
6.5.2	General characteristics.....	29
6.6	Static coefficient of friction.....	29
6.7	Parking brake application force provided by the different subsystems.....	29
6.7.1	Screw applied parking brake (tread brake).....	29
6.7.2	Spring applied tread brake unit.....	31
6.7.3	Screw applied parking brake (disc brake).....	32
6.7.4	Spring applied disc brake unit arrangement.....	33
6.7.5	Force of a permanent magnetic track brake, $F_{Mg,st}$ .....	34
6.8	Retention force of an individual wheelset, $F_{st,ax}(i, \tau_a)$ .....	34
6.9	Total retention force per train, $F_{st}(i, \tau_a)$ .....	35
6.10	Stationary brake safety calculation.....	35
6.10.1	General.....	35
6.10.2	Basic condition for holding on a slope.....	35
6.11	Safety ratio for stationary brake (retention safety), $S_{st}(i, \tau_a)$ .....	36
6.12	Static coefficient of wheel/rail adhesion required by each disc braked wheelset, $\tau_{req,st,ax}$ .....	36
6.13	Coefficient of wheel/rail adhesion required by each wheelset with block brake or tread brake.....	37
6.14	Maximum achievable gradient, $i_{max}$ .....	37
6.15	Additional results for stationary brake calculation for rail vehicle or unit.....	37
6.15.1	Safety against rolling, $S_{R(\alpha)}$ .....	37
6.15.2	Additional results for stationary brake calculation for rail vehicle or unit with a different relationship between braking force and load per wheelset.....	38
<b>Annex A (informative)</b>	<b>Methodology of stopping and slowing distance calculation.....</b>	<b>39</b>
<b>Annex B (informative)</b>	<b>Workflow for stationary brake calculations.....</b>	<b>41</b>
<b>Annex C (informative)</b>	<b>Examples for brake calculation.....</b>	<b>42</b>
<b>Annex D (informative)</b>	<b>Calculation of braking or retarding forces (non-stationary).....</b>	<b>55</b>
<b>Annex E (informative)</b>	<b>Additional results for stationary brake calculation for rail vehicle or unit with a different relationship between braking force and load per wheelset.....</b>	<b>60</b>
<b>Annex F (informative)</b>	<b>Tread brake with different lever length ratios.....</b>	<b>72</b>
<b>Bibliography</b>	<b>.....</b>	<b>73</b>

## 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](http://www.iso.org/directives)).

ISO draws attention to the possibility that the implementation of this document may involve the use of (a) patent(s). ISO takes no position concerning the evidence, validity or applicability of any claimed patent rights in respect thereof. As of the date of publication of this document, ISO had not received notice of (a) patent(s) which may be required to implement this document. However, implementers are cautioned that this may not represent the latest information, which may be obtained from the patent database available at [www.iso.org/patents](http://www.iso.org/patents). ISO shall not be held responsible for identifying any or all such patent rights.

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

For an explanation of 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 [www.iso.org/iso/foreword.html](http://www.iso.org/iso/foreword.html).

This document was prepared by Technical Committee ISO/TC 269, *Railway applications*, Subcommittee SC 2, *Rolling stock*.

This second edition cancels and replaces the first edition (ISO 20138-1:2018), which has been technically revised.

The main changes are as follows:

- ISO 24478 has been added to Clause 2;
- new terms “brake subsystem” and “mean swept radius” have been added to [Clause 3](#);
- [Clause 4](#) “Symbols” with [Table 1](#) have been revised;
- the symbols that are explained in [Table 1](#) have been deleted from formulae keys;
- [Clause 5](#) “Stopping and slowing distances calculation” has been revised;
- [Clause 6](#) “Stationary braking” has been revised;
- [Annex A](#) “Methodology of stopping and slowing distance calculation” has been revised;
- [Annex B](#) “Workflow for stationary brake calculations” has been revised;
- [Annex C](#) “Examples for brake calculation” has been revised;
- [Annex D](#) “Calculation of braking forces (non-stationary)” has been revised;
- [Annex E](#) “Additional results for stationary brake calculation for rail vehicle or unit with a different relationship between braking force and load per wheelset” and [Annex F](#) “Tread brake with different lever length ratios” have been added;
- the Bibliography has been revised.

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

## ISO/FDIS 20138-1:2025(en)

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](http://www.iso.org/members.html).

# iTeh Standards (<https://standards.iteh.ai>) Document Preview

ISO/FDIS 20138-1

<https://standards.iteh.ai/catalog/standards/iso/9372db98-a727-40d1-b1f9-a8f9dc0565eb/iso-fdis-20138-1>

## Introduction

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

This document (i.e. ISO 20138-1) and ISO 20138-2 complement each other but also can be used separately, depending on the requirements of the user.

- In this document, the braking force equals the retarding force, as the assumed braking forces used in a brake calculation never exceed the values which can be transferred by the assumed wheel/rail adhesion.
- ISO 20138-2 details the step by step calculation methodology utilizing instantaneous values of braking force provided by each operational brake system throughout the stopping or slowing time.

iTeh Standards  
(<https://standards.iteh.ai>)  
Document Preview

[ISO/FDIS 20138-1](https://standards.iteh.ai/catalog/standards/iso/9372db98-a727-40d1-b1f9-a8f9dc0565eb/iso-fdis-20138-1)

<https://standards.iteh.ai/catalog/standards/iso/9372db98-a727-40d1-b1f9-a8f9dc0565eb/iso-fdis-20138-1>