
**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



This document is a preview generated by EMS



COPYRIGHT PROTECTED DOCUMENT

© ISO 2018

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
Fax: +41 22 749 09 47
Email: copyright@iso.org
Website: www.iso.org

Published in Switzerland

Contents

Page

Foreword	v
Introduction	vi
1 Scope	1
2 Normative references	1
3 Terms and definitions	1
4 Symbols	2
5 Stopping and slowing distances calculation	7
5.1 General	7
5.2 Vehicle characteristics	8
5.2.1 Static mass, m_{st}	8
5.2.2 Equivalent rotating mass, m_{rot}	8
5.2.3 Dynamic mass, m_{dyn}	9
5.2.4 Wheel diameter	9
5.3 Adhesion wheel/rail dependent brake equipment type characteristics	9
5.3.1 Basic brake cylinder	9
5.3.2 Tread brake	11
5.3.3 Tread brake unit	13
5.3.4 Disc brake	15
5.3.5 Electro-dynamic brake	17
5.3.6 Fluid retarder	18
5.3.7 Transmission retarder	18
5.3.8 Rotating eddy current brake	18
5.4 Adhesion independent brake equipment type characteristics	18
5.4.1 Magnetic track brake	18
5.4.2 Linear eddy current brake	19
5.4.3 Mean retarding force by train resistance	20
5.4.4 Aerodynamic brake	21
5.4.5 Electro dynamic brake generated by linear induction motor	21
5.5 Time characteristics	21
5.5.1 Derivation of brake equipment time characteristics	21
5.5.2 Equivalent response time, t_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	24
5.6.3 Blending	25
5.6.4 Value of the mean adhesion required between wheel/rail for the braked wheelset	26
5.7 Stopping and slowing distance calculation based on mean values	27
5.7.1 Mean retarding force with respect to the distance	27
5.7.2 Equivalent deceleration, a_e , based on retarding forces	27
5.7.3 Equivalent free running distance, s_0	28
5.7.4 Stopping and slowing distance on level track	28
5.7.5 Stopping and slowing distance based on different gradients	29
5.8 Supplementary dynamic calculations	30
5.8.1 General	30
5.8.2 Braking energy	31
5.8.3 Maximum braking power of each brake equipment type, $P_{max,n}$	32
6 Stationary braking	32
6.1 General	32
6.2 Holding brake	32
6.3 Immobilization brake	32
6.4 Parking brake	32

6.5	Stationary brake calculation	33
6.5.1	General	33
6.5.2	General characteristics	33
6.6	Static coefficient of friction	33
6.7	Parking brake force provided by equipment type	33
6.7.1	Screw applied parking brake (tread brake)	33
6.7.2	Spring applied tread brake unit	36
6.7.3	Screw applied parking brake (disc brake)	37
6.7.4	Spring applied disc brake unit arrangement	39
6.7.5	Force of a permanent magnetic track brake	40
6.8	Stationary brake force for each wheelset	41
6.9	Total stationary brake force per train	41
6.10	Stationary brake safety calculation	42
6.11	Safety ratio for stationary brake	42
6.12	Coefficient of adhesion required by each disc braked wheelset	42
6.13	Maximum achievable gradient	43
6.14	Method for safety calculation for vehicles with a different relationship between brake force and load per wheelset	44
6.14.1	General	44
6.14.2	Mean adhesion value between wheel/rail	45
6.14.3	Safety against rolling	45
6.14.4	Safety against sliding	46
6.14.5	Retention force	52
6.14.6	Retention Safety	53
Annex A (informative)	Methodology of stopping and slowing distance calculation	54
Annex B (informative)	Workflow for stationary brake calculations	57
Annex C (informative)	Examples for brake calculation	60
Annex D (informative)	Calculation of braking forces (non-stationary)	75
Bibliography		80

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.

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.

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 20138-2¹⁾, *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.