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Railway applications — Railway braking — Country specific applications for ISO 20138-1

~~Publication~~

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Second edition

Date: 2022-10-11

Contents

Foreword

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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 22131:2018), which has been technically revised.

The main changes ~~are as follows:~~is: the symbols and terms in Clause 6 have been revised.

~~— editorial revision of symbols and terms in Clause 6.~~

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1 Scope

This document provides additional information to assist the understanding and the use of ISO 20138-1. The calculations in this document follow the same principles but they are slightly different.

This document contains country specific calculation approaches currently in use and represents the state of knowledge including for calculating:

— stopping and slowing distances;

— equivalent response time;

— brake performance;

— brake ratio.

2 Normative references

~~There are no normative references in this document.~~

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 20138-1:2018, *Railway applications — Calculation of braking performance (stopping, slowing and stationary braking) — Part 1: General algorithms utilizing mean value calculation*

3 Terms and definitions

~~No~~For the purposes of this document, the terms and definitions ~~are listed~~given in ~~this document~~ISO 20138-1 apply.

ISO and IEC maintain terminology 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/

4 Slowing or stopping distance calculation using a method implemented in France

4.1 General

This calculation is based on the alternative method of equivalent response time calculation, as used in the French railway requirements, in particular, for trains operating in “G” position.

4.2 ~~Terms,~~ Symbols and abbreviations

For the purpose of Clause 4, the terms, symbols and abbreviations defined in Table 1 apply.

Table 1 — Symbols~~, definitions~~ and ~~units~~abbreviations

~~Term, symbol~~ Symbol or abbreviation	~~Definition~~Description	Unit
1	Point when the brake force, deceleration or pressure has been substantially achieved, typically 95 %	—
a_e	Equivalent deceleration (on level track, without considering gradient effect)	m/s²
g	Standard acceleration of gravity	m/s²
“G” position	Distributor valve and distributor isolating devices (as defined in EN 15355[9])	—
i	Gradient of the track (positive rising/negative falling)	—
s_{grad}	Stopping/slowing distance on a gradient	m
s_{tests}	Stopping distances measured during the tests	m
t_a	delay time	s
t_{ab}	build-up time	s
t_e	Equivalent response time	s
$2 \cdot t_e$	Equivalent response time multiplied by 2	s
v_0	Initial speed	m/s
v_{fin}	Final speed (= 0 in the case of a stopping distance)	m/s
X	Time	s
Y	Factor of nominal braking force, deceleration or pressure	—

4.3 Slowing or stopping distance calculation

4.3.1 French model for “G” position

This model provides a high level of accuracy for the calculation of stopping distances of trains with long build up time (e.g. “G” position). It is currently used by the infrastructure managers in order to evaluate the conformance of a train with the train control system and the length of the signalling sections.

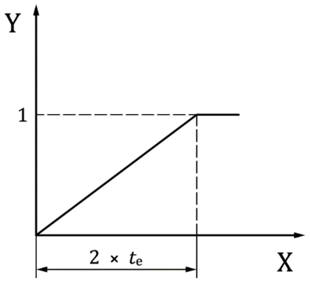
For this French model of slowing or stopping distance calculation, Figure 1 ~~may~~can be used for trains operating in “G” position for brake systems with retarding forces acting on rail contact point.

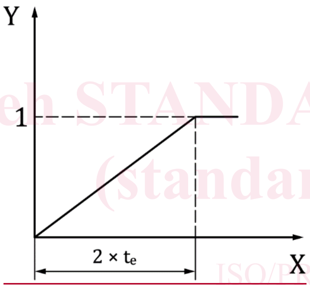
The model uses a linear development of the effort from 0 to 1 during a time of $2 \cdot t_e$.

The equivalent response time, t_e, can be calculated as set out in Formula (1):

$$t_e = t_a + \frac{t_{ab}}{2} \quad t_e = t_a + \frac{t_{ab}}{2} \quad (1)$$

withwhere t_a and t_{ab} are in accordance with ISO 20138-1:2018, 5.5.2.





Key

X time, in s

Y factor of nominal braking force, deceleration or pressure

X time, in s

1 point when the full brake force, deceleration or pressure has been achieved, typically 95 % of maximum value

2 × t_e equivalent response time multiplied by 2, in s

Figure 1 — Model based on a linear development of the effort from 0 to 1 during a time of 2 · t_e

The stopping (v_{fin} = 0) or slowing distance can be calculated as set out in Formula (2):

$$s_{grad} = v_0 \cdot t_e \cdot \frac{a_e}{a_e + g \cdot i} + \frac{v_0^2 - v_{fin}^2}{2 \cdot (a_e + g \cdot i)} - \frac{a_e \cdot t_e^2 \cdot (a_e + 4 \cdot g \cdot i)}{6 \cdot (a_e + g \cdot i)} \quad s_{grad} = v_0 \cdot t_e \cdot \frac{a_e}{a_e + g \cdot i} + \frac{v_0^2 - v_{fin}^2}{2 \cdot (a_e + g \cdot i)} - \frac{a_e \cdot t_e^2 \cdot (a_e + 4 \cdot g \cdot i)}{6 \cdot (a_e + g \cdot i)} \quad (2)$$

(2)

NOTE 1 The equivalent deceleration, a_e, does not take the effect of the gradient into account.

Formula (2) is valid for calculating the stopping/slowing distance with a fully established brake, provided that the ~~following~~ condition in Formula (3) is fulfilled:

$$v_0 - v_{fin} \geq (a_e + 2 \cdot i) \cdot t_e \qquad (3)$$

~~$v_0 - v_{fin} \geq (a_e + 2 \cdot i) \cdot t_e$~~ ~~(3)~~

where

s_{grad} is the stopping/slowing distance on a gradient, in m;

v_0 is the initial speed, in m/s;

t_e is the equivalent response time, in s;

a_e is the equivalent deceleration (on level track, without considering gradient effect), in m/s²;

g is the standard acceleration of gravity, in m/s²;

i is the gradient of the track (positive rising/negative falling);

v_{fin} is the final speed (= 0 in the case of a stopping distance), in m/s.

NOTE 2 The stopping/slowing distance as calculated by applying Formula (2) ~~will be~~is shorter than calculated according to the method described in ISO 20138-1:2018, 5.7.4.

4.3.2 Calculation using ISO 20138-1:2018, 5.7.5.1 ~~(~~step model~~)~~

ISO 20138-1:2018, 5.7.5.1 gives Formula (4) for calculations on level track (i = 0) or with gradient.

It uses the model for theoretical response time $t_e = t_a + \frac{t_{ab}}{2}$ ~~$t_e = t_a + \frac{t_{ab}}{2}$~~ as “step” model.

$$s_{grad} = v_0 \cdot t_e - \frac{1}{2}\frac{m_{st}}{m_{dyn}} \cdot g \cdot i \cdot t_e^2 + \frac{\left(v_0 - \frac{m_{st}}{m_{dyn}} \cdot g \cdot i \cdot t_e\right)^2 - v_{fin}^2}{2a_e} \qquad (4)$$

~~$s_{grad} = v_0 \cdot t_e - \frac{1}{2}\frac{m_{st}}{m_{dyn}} \cdot g \cdot i \cdot t_e^2 + \frac{\left(v_0 - \frac{m_{st}}{m_{dyn}} \cdot g \cdot i \cdot t_e\right)^2 - v_{fin}^2}{2a_e}$~~ ~~(4)~~

With train resistance and dynamic mass which compensate each other and v_{fin} = 0, the formula is simplified as Formula (5):

$$s_{grad} = v_0 \cdot t_e - \frac{g \cdot i \cdot t_e^2}{2} + \frac{(v_0 - g \cdot i \cdot t_e)^2}{2a_e} \qquad (5)$$

~~$s_{grad} = v_0 \cdot t_e - \frac{g \cdot i \cdot t_e^2}{2} + \frac{(v_0 - g \cdot i \cdot t_e)^2}{2a_e}$~~ ~~(5)~~

where

s_{grad} is the stopping/slowing distance on a gradient, in m;

v_0 is the initial speed, in m/s;

t_e is the equivalent response time, in s;

