

DIN EN 14531-1:2019-05 (E)

Railway applications - Methods for calculation of stopping and slowing distances and immobilization braking - Part 1: General algorithms utilizing mean value calculation for train sets or single vehicles (includes Amendment A1:2018)

Contents	Page
European foreword	4
Introduction	5
1 Scope	6
2 Normative references	6
3 Terms, definitions, symbols and indices	6
3.1 Terms and definitions	6
3.2 Symbols and indices	8
4 Stopping and slowing distances calculation	11
4.1 General	11
4.2 Accuracy of input values	11
4.3 General characteristics	12
4.3.1 Train formation	12
4.3.2 Characteristics of a train	12
4.4 Brake equipment type characteristics	14
4.4.1 General	14
4.4.2 Tread braking	16
4.4.3 Disc braking	16
4.4.4 Forces of friction brake (tread brake) equipment	16
4.4.5 Forces of friction brake (disc brake) equipment	22
4.4.6 Mean dynamic coefficient of friction (μ_d) tread and disc brakes	26
4.4.7 Brake forces of other brake equipment types	26
4.4.8 Time characteristics	35
4.4.9 Blending concept	38
4.4.10 Sharing, proportioning of the brake forces - achieved forces	39
4.5 Initial and operating characteristics	39
4.5.1 Gradient of the track	39
4.5.2 Initial speed	40
4.5.3 Coefficient of adhesion	40
4.5.4 Level of the brake demand	41
4.5.5 Quantity of each brake equipment type available	41
4.5.6 Calculation in degraded conditions	41
4.6 Total decelerating force at train level	42
4.7 External forces	42
4.7.1 Gradient	42
4.7.2 Wind force on the train	42
4.7.3 Train resistance	42
4.8 Stopping and slowing distance calculation based on mean values	43
4.8.1 General	43
4.8.2 Mean braking force with respect to the distance	43
4.8.3 Equivalent deceleration (a_e) based on mean forces	43
4.8.4 Mean decelerations supplied by each braking force (a_{ia})	44
4.8.5 Equivalent free run distance (s_0)	44
4.8.6 Stopping and slowing distance on level track (s)	45
4.8.7 Stopping and slowing distance on a gradient (s _{grad})	45

4.8.8	Other specific formulae for the calculation of stopping distance	46
4.9	Supplementary dynamic calculations	46
4.9.1	General	46
4.9.2	Mass to be braked (mB)	47
4.9.3	Braking energy	47
4.9.4	Maximum braking power of each brake equipment type	49
4.9.5	Maximum specific power flux for each type of friction brake	49
4.10	Specific expressions of braking performance	50
4.10.1	General	50
4.10.2	Braked weight percentage (%)	50
4.10.3	Braked weight	50
4.10.4	Braking ratio	50
4.10.5	Equivalent brake force	50
5	Immobilization brake calculation	50
5.1	General	50
5.2	General characteristics	50
5.3	Static coefficient of friction	51
5.4	Train and operating characteristics	51
5.5	Immobilization force provided by equipment type	51
5.5.1	General	51
5.5.2	Force of a screw hand brake (Tread brake)	52
5.5.3	Force of a screw hand brake (Disc brake)	52
5.5.4	Force of a tread brake unit	52
5.5.5	Force of a disc brake unit arrangement	53
5.5.6	Force of a permanent magnetic track brake	53
5.6	Immobilization force for each axle	54
5.7	Total immobilization force per train	54
5.8	Immobilization safety factor	55
5.9	Coefficient of adhesion required by each braked axle	55
5.10	Maximum achievable gradient	56
Annex A (informative) Workflow of stopping and slowing distance calculation method		57
Annex B (informative) Workflow of immobilization calculations		59
Annex C (informative) Brake equipment type example calculations		60
Annex D (informative) Train stopping distance and immobilization brake calculation example		72
D.1	General	72
D.2	Train stopping calculations	73
D.3	Train stopping calculations on a gradient	75
D.4	Train immobilization (parking) brake calculations	75
Annex E (informative) Development of the formula for the mean brake force with respect to the braking distance		77
Annex F (informative) Slowing or stopping distance calculation using alternative method of equivalent response time calculation as French Railway requirements in particular for trains operating in 'G' position		78
Annex ZA (informative) Relationship between this European Standard and the Essential Requirements of EU Directive 2008/57/EC		80
Bibliography		83