

Table of contents

Foreword	5
1 Basic characteristics of rail transport	6
1.1 Fundamental principles of rail transport.....	6
1.2 Comparison of rail transport with other modes of transport.....	8
2 Modelling the train motion	11
2.1 Train equation of motion and coefficient of rotating masses	13
2.2 Numerical solution of the train equation of motion.....	17
3 Running resistances	20
3.1 Vehicle resistances	20
3.1.1 Rolling resistance	21
3.1.2 Resistance in bearings.....	22
3.1.3 Aerodynamic drag	24
3.1.4 Mathematical description of vehicle resistance for practical use.....	26
Vehicle resistance formulas used in the Czech Republic	27
A few remarks on the problem of vehicle running resistance of rolling stock	28
Selected foreign approaches to estimating the magnitude of vehicle resistance .	30
3.2 Track resistances.....	31
3.2.1 Track gradient resistance	31
3.2.2 Curving resistance.....	32
3.2.3 Tunnel resistance.....	36
3.2.4 Equivalent and reduced track gradient.....	36
3.3 Results of research activities of the Faculty of Transport Engineering (DFJP) in the field of running resistances.....	38
4 Tractive effort	41
4.1 Generation of tractive effort on the wheels.....	41
4.2 Traction characteristics	46
4.2.1 $F-v$ curves of electric tractive vehicles	49
Vehicles with rheostatic traction power control.....	50
Vehicles with tapped traction power control.....	51
Vehicles with pulse traction power control.....	52
Vehicles with asynchronous traction drive	53
4.2.2 $F-v$ curves of internal combustion engine-driven tractive vehicles	55
Vehicles with mechanical power transmission	56
Vehicles with hydraulic power transmission.....	56
Vehicles with electric power transmission.....	60
5 Braking effort	65
5.1 Generation of braking effort on the wheels	65
5.2 Mechanical part of the brake	69
5.3 Pneumatic part of the brake	71
5.4 Dynamic and adhesion independent brakes.....	75
5.5 Braking performance of rolling stock.....	77

6	Train running at constant speed and hauling capability calculations.....	79
6.1	Train running at constant speed	79
6.2	Calculations of hauling capability of tractive vehicles	81
6.2.1	Analytical method for determining hauling capability – static principle.....	82
	Hauling capability for setting the train in motion (start-up).....	83
	Hauling capability for train passage.....	84
	Hauling capability for run-up.....	84
6.2.2	Analytical method for determining hauling capability – dynamic principle	85
6.2.3	Graphical method for determining hauling capability.....	86
7	Calculations of travel times and energy consumption.....	89
7.1	Calculations of travel times.....	89
7.2	Energy consumption calculations.....	91
8	Traction mechanics issues in a wider context.....	94
8.1	Coupling gear design issues.....	94
8.2	Train braking issues.....	95
8.3	Issues of electrical power supply for railways	97
8.4	Automation of train operation.....	98
8.5	Relationship to rolling stock and railway infrastructure parameters.....	99
	Reference list.....	102
	Practice exercises.....	105
	Notes	109