

CONTENTS OF THE BASIC RAILWAY ENGINEERING COURSE

1.	INTRODUCTION		
1.1	Historic development		
1.2	Railways		
1.3	Tramways and metro		
1.4	Operational aspects		
1.4.1	Functions of a railway company		
1.4.2	Infrastructure		
1.4.3	Rolling stock		
1.4.4	Personnel		
1.4.5	Electrification		
1.4.6	Catenary systems		
1.4.7	Road crossings		
1.4.8	Major rail infrastructure projects		
1.4.9	Developing countries		
1.5	Geometry of a railway line		
1.5.1	Clearances		
1.5.2	Alignment		
1.6	General track considerations		
1.6.1	Track requirements		
1.6.2	Load-bearing function of the track		
1.6.3	Track geometry components		
2.	WHEEL-RAIL PRINCIPLES		
2.1	Wheel-rail guidance		
2.2	Wheelset and track dimensions		
2.3	Conicity		
2.4	Lateral movement of a wheelset on straight track		
2.4.1	Theory according to Klingel		
2.4.2	Hunting movement		
2.5	Equivalent conicity		
2.6	Worn wheel profiles		
2.7	Wheel-rail contact stresses		
2.7.1	Hertz theory		
2.7.2	Hertz patterns		
2.7.3	Hertz spring constant		
2.7.4	Single and two-point contact between wheel and rail		
2.7.5	Spreading forces		
2.7.6	Wheel-rail creep		
2.7.7	Spin		
2.8	Train resistances		
2.8.1	Types of resistances		
2.8.2	Required pulling force		
2.8.3	Adhesion force		
3.	CURVES AND GRADIENTS		
3.1	General considerations		
3.2	Horizontal curves		
3.2.1	Curve radius/curvature		
3.2.2	Curve effects		
3.3	Superelevation (or cant)		
3.3.1	General considerations		
3.3.2	Cant deficiency		
		3.3.3	Effect of suspension on lateral acceleration
		3.3.4	Effect of body tilt coaches on cant deficiency
		3.3.5	Switches and other constraints
		3.3.6	Cant excess
		3.3.7	Maximum cant
		3.4	Transition curves
		3.4.1	General remarks
		3.4.2	Clothoid
		3.4.3	Cubic parabola
		3.4.4	Curve displacement
		3.5.	Cross level transitions
		3.5.1	Relation with the transition curve
		3.5.2	Length of normal transition curve
		3.5.3	Adjacent curves
		3.6	Curve resistance
		3.7	Gradients
		3.7.1	Gradient resistance
		3.7.2	Magnitude of gradient
		3.7.3	Vertical rounding off curves
		3.7.4	Guidelines for permissible quasi-static accelerations
		3.8	Alignment in mountainous area
		4	TRACK LOADS
		4.1	General
		4.2	Axle loads
		4.3	Line classification
		4.4	Tonnages
		4.5	Speeds
		4.6	Causes and nature of track loads
		4.7	Vertical forces
		4.7.1	Total wheel load
		4.7.2	Tilting risk
		4.8	Lateral forces
		4.8.1	Total lateral load
		4.8.2	Derailment risk
		4.8.3	Lateral force on the track
		4.9	Longitudinal forces
		4.9.1	Causes
		4.9.2	Temperature forces
		4.9.3	Track creep
		4.9.4	Braking load
		4.10	Influence of higher speeds and increased axle loads
		4.10.1	Speed
		4.10.2	Increase in axle loads
		4.11	Wheel flats
		4.12	Forces due to bad welds
		4.13	Axle box accelerations
		5.	TRACK CONSTRUCTION
		5.1	Introduction

5.2	Formation	6.5.4	Transition between plain track and bridge
5.3	Ballast bed	6.6	Tramway Track
5.4	Rails	6.6.1	Tramway track characteristics
5.4.1	Functions	6.6.2	Examples of paved-in tramway track
5.4.2	Types of profile	6.7	Crane Track
5.4.3	Geometry of flat-bottom rail	6.8	High speed track and heavy haul track
5.4.4	Modern rail manufacturing	6.8.1	High Speed Track
5.4.5	Ingot casting	6.8.2	Magnetic levitation Track
5.4.6	Continuous casting	6.8.3	Heavy Haul Track
5.4.7	Finishing shop		
5.5	Rail properties	7.	SWITCHES AND CROSSINGS
5.5.1	Metallurgical fundamentals	7.1	The standard turnout
5.5.2	Heat treatment	7.1.1	Set of switches
5.5.3	Rail grades	7.1.2	Common crossing
5.5.4	Wear resistance	7.1.3	Closure rail
5.5.5	Fatigue strength	7.1.4	Rails and sleepers in turnouts
5.6	Rail failures	7.2	Geometry of the turnout
5.6.1	Introduction	7.3	High-speed turnouts
5.6.2	Fatigue crack	7.4	Notations used for switches and crossings
5.6.3	Corrugation	7.5	Types of turnout and crossing
5.7	Rail joints and welds	7.6	Crossovers
5.7.1	Introduction	7.7	Switch calculation
5.7.2	Fish-plated joints	7.7.1	Relation between curve radius and crossing angle
5.7.3	Expansion joints and expansion devices	7.7.2	Calculation of main dimensions
5.7.4	Bridge transition structures	7.7.3	Geometrical design of switches and crossings
5.7.5	Insulated joint	7.7.4	Short dictionary of turnout related words
5.7.6	Flash butt weld		
5.7.7	Thermit weld	8.	STATIC TRACK DESIGN
5.7.8	Electric arc weld	8.1	Introduction
5.8	Sleepers	8.2	Calculation via beams on an elastic foundation
5.8.1	Introduction	8.3	Double beam
5.8.2	Timber sleepers	8.4	Rail stresses
5.8.3	Concrete sleepers	8.4.1	Stresses in rail foot centre
5.8.4	Steel sleepers	8.4.2	Stresses in the rail head
5.9	Fastenings	8.4.3	Rail stresses due to a combined Q/Y load
5.9.1	Introduction	8.5	Sleeper stresses
5.9.2	Subdivision of fastenings	8.6	Stresses on ballast bed and formation
5.9.3	Baseplates	8.6.1	Introduction
5.9.4	Elastic fastenings	8.6.2	Vertical stress on ballast bed
5.9.5	Rail pads	8.6.3	Vertical stress on formation
6.	TRACK SYSTEMS	8.6.4	Classes of quality of soils
6.1	Level crossings	8.7	Computer models
6.1.1	Lightweight universal plates	8.7.1	GEOTRACK program
6.1.2	Heavy universal plates	8.7.2	Pasternak model
6.1.3	Harmelen level crossing		
6.2	Track on structures	9.	DYNAMIC TRACK DESIGN
6.2.1	Track on structures with a continuous ballast bed and sleepers	9.1	Introduction
6.2.2	Track on structures without a ballast bed	9.2	Dynamic principles
6.3	Direct fastening system	9.2.1	General
6.4	Reinforcing layers	9.2.2	One mass spring system
6.5	Unconventional track systems		
6.5.1	Ballasted track versus ballastless track		
6.5.2	Use of ballastless track		
6.5.3	Track resilience		

9.2.3	Wheel/rail forces	11.7	Stone blowing
9.3	Track modelling	11.8	Design tamping
9.3.1	Transfer function between track load and track displacement	11.9	Ballast stabiliser
9.3.1.1	Beam on an elastic foundation	11.10	Ballast cleaner
9.3.1.2	Double beam	11.11	High temperatures
9.3.1.3	Beam on an elastic foundation (moving load)	11.12	Maintenance of the track structure
9.3.2	Discrete support	11.12.1	Rails
9.4	Vertical wheel response	11.12.2	Sleepers
9.4.1	Hertzian contact spring	11.12.3	Switch maintenance
9.4.2	Transfer functions between wheel and rail	11.13	General observations on track renewal
9.5	Applications of advanced dynamic models	11.14	Manual track renewal
9.5.1	Introduction	11.14.1	Renewal of sleepers
9.5.2	The RAIL program	11.14.2	Renewal of rails
9.5.3	The SPOOR program	11.15	Mechanical track renewal
9.6	Dynamic experiments	11.15.1	Introduction
9.6.1	Introduction	11.15.2	Track possession
9.6.2	Approach on Embedded Rail Structures	11.15.3	Gantry crane method
9.6.3	Data analysis	11.15.4	Track section method
9.6.4	RAIL modelling and calculations of short specimens	11.15.5	Continuous method
9.6.5	Results of short specimens	11.15.6	Track renewal trains
10	TRACK STABILITY AND LONGITUDINAL FORCES.	11.16	Switch renewal
10.1	Introduction	11.17	Track laying
10.2	Simple track stability models	11.17.1	General considerations
10.2.1	Straight beam in buckling in case of an elastic lateral resistance	11.17.2	Track construction trains
10.2.2	Rail track buckling with misalignment and constant lateral shear resistance	11.17.3	Platow system
10.3	Advanced track buckling models	11.17.4	TGV tracks France
10.4	Longitudinal forces	12	INSPECTION AND DETECTION METHODS
10.4.1	General considerations	12.1	Ultrasonic rail inspection
10.4.2	Modelling of the longitudinal force problem	12.1.1	Introduction
10.4.3	Example of longitudinal force calculations	12.1.2	The NS ultrasonic train
11	TRACK MAINTENANCE	12.1.3	Probe system
11.1	Introduction	12.1.4	Detection area
11.2	General maintenance aspects.	12.1.5	NS Ultrasonic inspection program
11.3	Manual method of track geometry improvement	12.2	Recording systems
11.4	Rail-grinding trains	12.2.1	Introduction
11.5	Correcting weld geometry	12.2.2	Some aspects of geometry recording
11.5.1	STRAIT principle	12.2.3	Assessment of track quality for maintenance decisions
11.5.2	Mobile weld correction	12.2.4	The NS track recording system BMS
11.6	Tamping machines	12.3	Recording of track geometry according to BMS-1
11.6.1	General considerations	12.3.1	Selecting the measuring system
11.6.2	Tamping principle	12.3.2	Measuring principle
11.6.3	Smoothing principle of modern tamping machines	12.3.3	Instrumentation
		12.3.4	Signal analysis
		12.3.5	Analog output
		12.4	Recording of vertical rail and weld geometry using BMS-2
		12.5.	Deterioration of track geometry
		12.5.1	Introduction
		12.5.2	Deterioration rates of geometry
		12.6.	Computer-aided track maintenance and renewal
		12.6.1	Philosophy

12.7	Basic data for predicting and planning	13.3	Ground vibrations
12.7.1	Introduction	13.3.1	Introduction
12.7.2	Track geometry	13.3.2	Wave propagation in soils
12.7.3	Management information	13.3.3	Human perception
12.7.4	Rational rail management	13.3.4	Measured vibrations
12.7.5	ECOTRACK	13.3.5	Vibration reduction
13	RAILWAY-INDUCED GROUND VIBRATIONS AND NOISE	13.3.6	Measures for ballastless track
13.1	Introduction	13.3.7	Measures for slab track
13.2	Some definitions	13.3.8	Measures for tracks in the open
		13.4	Railway noise