

guide for the design of river dikes

volume 1 - upper river area



TECHNICAL ADVISORY COMMITTEE ON WATER DEFENCES
CENTRE FOR CIVIL ENGINEERING RESEARCH AND CODES

CONTENTS

	UNITS, SYMBOLS, AND DEFINITIONS	9
Chapter	1	INTRODUCTION 15
	1.1	General. 15
	1.2	Outline. 17
	1.3	Summary of "Guidelines for the design of river dikes, Volume 2 - Tidal river area" 18
Chapter	2	STARTING-POINTS FOR THE DESIGN 20
	2.1	Safety against flooding 20
	2.2	Management and maintenance 21
	2.3	Scenic, historico-cultural, and ecological values 22
	2.4	Cost 23
Chapter	3	DESIGN 24
	3.1	Survey of the existing situation 24
	3.2	Hydraulic boundary conditions 25
	3.3	Assessment of the existing situation and a broad plan for a new design 26
	3.4	Soil mechanics investigation 26
	3.5	Determination of pore-water pressures and piezometric head 29
	3.6	Basic design for representative cross-sections 29
	3.6.1	Crest level/freeboard 30
	3.6.2	Watertightness 30
	3.6.3	Resistance to erosion 31
	3.6.4	Safety with respect to internal erosion and loss of stability 32
Chapter	4	EXECUTION ASPECTS 35
Chapter	5	MANAGEMENT AND MAINTENANCE 40
Chapter	6	SAFETY IN STRENGTH AND STABILITY ANALYSIS 41
	6.1	General. 41
	6.2	Mathematical model with mean values and one general safety factor 42
	6.3	Mathematical model with representative values and partial safety factors 43

Chapter	7	LOADS ON THE FLOOD DEFENCE	47
	7.1	Flood load	47
	7.1.1	Design water levels	48
	7.1.2	Profile of the design discharge wave	48
	7.1.3	Determinant duration of high water levels	49
	7.2	Wind load	49
	7.2.1	Wave action	49
	7.2.2	Wind set-up	54
	7.2.3	Wind load via structures	54
	7.2.4	Design values for wind velocities and directions	54
	7.3	Traffic load	55
	7.4	Dead load	55
	7.5	Exceptional loads	55
	7.6	Biological effects	56
Chapter	8	STRENGTH OF THE FLOOD DEFENCE	58
	8.1	Crest level	58
	8.2	Geometry	59
	8.3	Strength and stiffness properties of the soil	59
	8.3.1	Shearing strength of the soil	60
	8.3.2	Compressibility of the soil	61
Chapter	9	SOIL MECHANICS AND GEOHYDROLOGY INVESTIGATION	66
	9.1	Introduction	66
	9.2	Geology	67
	9.3	Topographical material	69
	9.4	Soil types and properties	70
	9.5	Site investigations	72
	9.5.1	Goelectrical and electromagnetic investigation	72
	9.5.2	Cone penetration tests	75
	9.5.3	Borings	79
	9.5.4	Vane tests	83
	9.5.5	Pumping and well tests	85
	9.5.6	Infiltration tests	85
	9.6	Laboratory testing	86
	9.6.1	Determination of mass and volume properties	86
	9.6.2	Permeability tests	86
	9.6.3	Tests for the determination of shear strength parameters	87
	9.6.4	Oedometer tests	94
	9.7	Characteristic values and material factors	94
	9.7.1	Characteristic values for soil parameters	95
	9.7.2	Partial material factors	98

Chapter	10	PORE-WATER PRESSURES AND PIEZOMETRIC HEAD	100
	10.1	Groundwater flow in river dikes	100
	10.1.1	Steady and unsteady flow	101
	10.1.2	Flow in the saturated capillary zone	103
	10.1.3	Flow at layer interfaces	104
	10.1.4	Steady flow for isotropic and anisotropic permeability	105
	10.1.5	Hydraulic fracturing and limit potential head	106
	10.2	Computational models	107
	10.2.1	General	107
	10.2.2	Analytical models	108
	10.2.3	Numerical models	109
	10.2.4	Analogue models	110
	10.2.5	Graphical approach	111
	10.3	Piezometer observations and pore-water pressure measurements	112
	10.3.1	Extrapolation from records at high river water level	113
	10.3.2	Extrapolation from momentaneous levels	113
Chapter	11	DESIGN CALCULATIONS	115
	11.1	Freeboard and construction height	115
	11.2	Settlements, subsidence, and horizontal displacements	116
	11.3	Stability of the earth body of the dike	117
	11.3.1	Slip circle analysis	118
	11.3.2	Simplified Bishop method of slices	121
	11.3.3	Safety against sliding	124
	11.4	Stability of surface layers on the dike slopes	126
	11.4.1	Flow force and hydraulic gradient of the groundwater flow	127
	11.4.2	Equilibrium parallel and perpendicular to the slope	129
	11.4.3	Partial factors of safety to be applied	130
	11.4.4	Some applications	131
	11.5	Sand-carrying wells or sand boils	133
	11.5.1	Design criteria	134
	11.5.2	Measures for the prevention or limitation of sand boils	139
	11.6	Stability of closed revetments	142
	11.6.1	Calculation of the maximum uplift pressure	142
	11.6.2	Limit states of sliding and heaving	144
	11.6.3	Load situations and partial factors of safety	145
	11.7	Stability of open revetments	146
Chapter	12	STRUCTURAL DESIGN ASPECTS	148
	12.1	The dike	148
	12.1.1	Dike alignment	148

12.1.2	Dike profile	149
12.1.3	Clay covering on slopes and crest	150
12.1.4	Grass blanket on slopes and crest	153
12.1.5	Resistance to erosion of inner slope and crest	154
12.1.6	Protections on the outer slope	156
12.1.7	Drainages and filter constructions.	161
12.1.8	Sheet pile walls, retaining walls, cofferdams and low dike walls	163
12.1.9	Watertight screens (flow cut-offs).	164
12.2	Water-retaining structures in dikes	170
12.3	Strange objects in, on, and near the dike	171
12.3.1	Vegetation	171
12.3.2	Buildings	171
12.3.3	Cables and conduits	173
12.4	Scour-holes and oxbow lakes near the dike	174
12.4.1	Deep scour-holes behind the dike.	174
12.4.2	Scour-hole or oxbow lake outside the dike	176
	REFERENCES	178
Appendix A	ANALYTICAL SOLUTIONS FOR A FEW CASES OF STEADY FLOW .	180
A1	Flow through a covering clay layer	180
A2	Flow in a sandy subsoil under an impermeable dike, with covering, poorly permeable layers in the foreland and the hinterland, without radial entrance or exit of water	180
A3	Flow in a sandy subsoil under an impermeable dike, with impermeable layers in the foreland and the hinterland, and with radial entrance and exit of water.	184
A4	Flow in a sandy subsoil under an impermeable dike and berm, where a limit potential head occurs behind the dike	187
Appendix B	ADJUSTMENT OF PORE-WATER PRESSURES IN A CLAY LAYER WITH ELASTIC STORAGE	189
Annexes		191