

Recommendations on Excavations

EAB

2nd Edition

Translation of the 4th German Edition

Published by
the German Geotechnical Society
(Deutsche Gesellschaft für Geotechnik e.V., DGGT)

Contents

Members of the Working Group for Excavations	V
Preface	VII
Notes for the user	XVI
1 General Recommendations	1
1.1 Engineering requirements for applying the Recommendations (R 1)...	1
1.2 Governing regulations (R 76)	1
1.3 New safety factor approach (R 77)	3
1.4 Limit states (R 78)	5
1.5 Support of retaining walls (R 67).....	6
1.6 Using the EAB in conjunction with Eurocode 7-1 (R 105, draft).....	7
2 Analysis principles	10
2.1 Actions (R 24)	10
2.2 Determination of soil properties (R 2).....	11
2.3 Earth pressure angle (R 89).....	13
2.4 Partial safety factors (R 79).....	15
2.5 General requirements for adopting live loads (R 3)	16
2.6 Live loads from road and rail traffic (R 55).....	18
2.7 Live loads from site traffic and site operations (R 56).....	20
2.8 Live loads from excavators and lifting equipment (R 57)	22
3 Magnitude and distribution of earth pressure	25
3.1 Magnitude of earth pressure as a function of the selected construction method (R 8).....	25
3.2 Magnitude of active earth pressure without surcharge loads (R 4) ...	26
3.3 Distribution of active earth pressure load without surcharges (R 5) ..	29
3.4 Magnitude of active earth pressure from live loads (R 6)	32
3.5 Distribution of active earth pressure from live loads (R 7)	34
3.6 Superimposing earth pressure components with surcharges (R 71)...	37
3.7 Determination of at-rest earth pressure (R 18).....	39
3.8 Earth pressure in retreating states (R 68)	41

4	General stipulations for analysis	43
4.1	Stability analysis (R 81).....	43
4.2	General information on analysis methods (R 11)	44
4.3	Determination and analysis of embedment depth (R 80).....	48
4.4	Determination of action effects (R 82)	51
4.5	Limit load design method (R 27)	53
4.6	Modulus of subgrade reaction method (R 102)	54
4.7	Finite-element method (R 103).....	60
4.8	Verification of the vertical component of the mobilised passive earth pressure (R 9).....	64
4.9	Verification of the transmission of vertical forces into the subsurface (R 84)	67
4.10	Stability analyses for braced excavations in special cases (R 10)	69
4.11	Verification of serviceability (R 83)	71
4.12	Allowable simplifications in the STR limit state (R 104, draft).....	74
5	Analysis approaches for soldier pile walls	77
5.1	Determination of load models for soldier pile walls (R 12)	77
5.2	Pressure diagrams for supported soldier pile walls (R 69)	78
5.3	Passive earth pressure for soldier pile walls with free earth supports (R 14)	81
5.4	Toe restraint for soldier pile walls (R 25).....	83
5.5	Equilibrium of horizontal forces for soldier pile walls (R 15)	86
6	Analysis approaches for sheet pile walls and in-situ concrete walls	90
6.1	Determination of load models for sheet pile walls and in-situ concrete walls (R 16)	90
6.2	Pressure diagrams for supported sheet pile walls and in-situ concrete walls (R 70)	92
6.3	Ground reactions and passive earth pressure for sheet pile walls and in-situ concrete walls (R 19)	94
6.4	Toe restraint for sheet pile walls and in-situ concrete walls (R 26)	96
7	Anchored retaining walls	101
7.1	Magnitude and distribution of earth pressure for anchored retaining walls (R 42).....	101
7.2	Analysis of force transmission from anchors to the ground (R 43)	102
7.3	Analysis of stability at low failure plane (R 44)	103
7.4	Analysis of global stability (R 45)	109
7.5	Measures to counteract displacements in anchored retaining walls (R 46)	112

8	Excavations with special ground plans	114
8.1	Excavations with circular plan (R 73)	114
8.2	Excavations with oval plan (R 74)	119
8.3	Excavations with rectangular plan (R 75) (11/05)	125
9	Excavations adjacent to structures	130
9.1	Engineering measures for excavations adjacent to structures (R 20)	130
9.2	Analysis of retaining walls with active earth pressure for excavations adjacent to structures (R 21)	132
9.3	Active earth pressure for large distances to structures (R 28)	134
9.4	Active earth pressure for small distances to structures (R 29)	137
9.5	Analysis of retaining walls with increased active earth pressure (R 22)	139
9.6	Analysis of retaining walls with at-rest earth pressure (R 23)	143
9.7	Mutual influence of opposing retaining walls for excavations adjacent to structures (R 30)	148
10	Excavations in water	151
10.1	General remarks for excavations in water (R 58)	151
10.2	Seepage pressure (R 59) (11/05)	153
10.3	Dewatered excavations (R 60)	154
10.4	Analysis of hydraulic heave safety (R 61)	156
10.5	Analysis of buoyancy safety (R 62)	160
10.6	Stability analysis of retaining walls in water (R 63)	167
10.7	Design and construction of excavations in water (R 64)	171
10.8	Water management (R 65)	174
10.9	Monitoring excavations in water (R 66)	175
11	Excavations in unstable rock	177
11.1	General recommendations for excavations in unstable rock (R 38)	177
11.2	Magnitude of rock pressure (R 39)	179
11.3	Distribution of rock pressure (R 40)	182
11.4	Bearing capacity of rock for support forces at the wall toe (R 41)	183
12	Excavations in soft soils	184
12.1	Scope of Recommendations R 91 to R 101 (R 90)	184
12.2	Slopes in soft soils (R 91)	185
12.3	Wall types in soft soils (R 92)	187
12.4	Construction procedure in soft soils (R 93)	190
12.5	Shear strength of soft soils (R 94)	194

12.6	Earth pressure on retaining walls in soft soils (R 95)	199
12.7	Ground reactions for retaining walls in soft soils (R 96)	203
12.8	Water pressure in soft soils (R 97)	209
12.9	Determination of embedment depths and action effects for excavations in soft soils (R 98)	214
12.10	Further stability analyses for excavations in soft soils (R 99)	216
12.11	Drainage measures in excavations in soft soils (R 100)	220
12.12	Serviceability of excavation structures in soft soils (R 101)	221
13	Verification of bearing capacity of structural elements	224
13.1	Material parameters and partial safety factors for structural element resistances (R 88)	224
13.2	Bearing capacity of soldier pile infilling (R 47)	225
13.3	Bearing capacity of soldier piles (R 48)	229
13.4	Bearing capacity of sheet piles (R 49)	230
13.5	Bearing capacity of in-situ concrete walls (R 50)	233
13.6	Bearing capacity of waling (R 51)	235
13.7	Bearing capacity of struts (R 52)	236
13.8	Bearing capacity of trench sheeting and bracing (R 53)	239
13.9	Bearing capacity of provisional bridges and excavation covers (R 54)	239
13.10	External bearing capacity of soldier piles, sheet pile walls and cast in-situ concrete walls (R 85)	241
13.11	Bearing capacity of tension piles and ground anchors (R 86)	244
14	Measurements and monitoring of excavation structures	245
14.1	Purpose of measurements and monitoring (R 31)	245
14.2	Preparation, implementation and evaluation of measurements (R 32)	246
14.3	Measured variables (R 33)	248
14.4	Measurement methods and measurements systems (R 34)	249
14.5	Location of measurement points (R 35)	250
14.6	Measurement times (R 36)	251
14.7	Transfer and processing of measurement results (R 37)	252
Appendix	253
A 1:	Relative density of cohesionless soils (10/05)	253
A 2:	Consistency of cohesive soils (10/05)	254
A 3:	Properties of cohesionless soils (10/05)	255
A 4:	Soil properties of cohesive soils (10/05)	257
A 5:	Guide values for the modulus of subgrade reaction $k_{s,h}$ for wet soils	260
A 6:	Partial safety factors for geotechnical variables	261

A 7:	Material properties and partial safety factors for concrete and reinforced concrete structural elements	263
A 8:	Material properties and partial safety factors for steel structural elements	265
A 9:	Material properties and partial safety factors for wooden structural elements	266
A 10:	Empirical values for skin friction and base resistance of sheet pile walls and soldier piles	268
Bibliography	269
Terms and notation	278
Geometrical variables	278	
Subsoil and soil parameters	278	
Earth pressure and passive earth pressure	279	
Further loads, forces and action effects	280	
Analyses using the partial safety factor approach	280	
Miscellany	281	
Recommendations in numerical order	282	