

# DIN 1054:2021-04 (E)

## Subsoil - Verification of the safety of earthworks and foundations - Supplementary rules to DIN EN 1997-1

### Contents

Page

Foreword .....	7
1 Scope .....	9
A 1.1.4 Scope of DIN 1054 .....	9
2 Rules supplementary to DIN EN 1997-1:2009-09.....	9
Re "1.2 Normative references" .....	9
Re "1.3 Assumptions" .....	12
Re "1.4 Distinction between principles and application rules" .....	12
Re "1.5 Definitions" .....	12
A 1.5.3 Further definitions .....	12
Re "1.6 Symbols" .....	12
A 1.6 Additional symbols .....	12
Re "2 Basis of geotechnical design".....	17
Re 2.1 "Design requirements" .....	17
A 2.1.1 Provisions for design situations and limit states.....	17
A 2.1.2 Geotechnical categories .....	17
Re "2.2 Design situations" .....	20
Re "2.4 Geotechnical design by calculation" .....	21
Re "2.4.1 General" .....	21
Re "2.4.2 Actions" .....	22
Re "2.4.5 Characteristic values" .....	24
Re "2.4.6 Design values" .....	24
Re "2.4.7 Ultimate limit states" .....	25
Re "2.4.8 Serviceability limit states" .....	34
Re "2.4.9 Limiting values for movements of foundations" .....	35
Re "2.5 Design by prescriptive measures" .....	35
Re "2.7 Observational method" .....	35
Re "2.8 Geotechnical Design Report" .....	36
Re "3 Geotechnical data" .....	37
Re "3.1 General" .....	37
A 3.1.1 Non-cohesive soils.....	37
A 3.1.2 Cohesive soils .....	37
A 3.1.3 Organic and organogenic soils .....	37
Re "3.2 Geotechnical investigations" .....	37
Re "3.2.1 General" .....	37
Re "3.3 Evaluation of geotechnical parameters" .....	37
Re "3.3.1 General" .....	37
Re "3.3.2 Characterization of soil and rock type" .....	38
Re "3.3.3 Weight density" .....	38
Re "3.3.6 Shear strength" .....	38
Re "3.3.7 Soil stiffness" .....	39
Re "3.3.9 Permeability and consolidation parameters of soil and rock" .....	39
Re "3.4 Ground Investigation Report" .....	39
Re "3.4.1 Requirements" .....	39
Re "3.4.2 Presentation of geotechnical information" .....	39
Re "3.4.3 Evaluation of geotechnical information" .....	40

Re "4 Supervision of construction, monitoring and maintenance" .....	40
Re "4.1 General" .....	40
Re "4.2 Supervision" .....	40
Re "4.5 Monitoring" .....	40
Re "6 Spread foundations" .....	40
Re "6.1 General" .....	40
A 6.1.1 Scope and general requirements.....	40
A 6.1.2 Classification into geotechnical categories .....	40
Re "6.4 Design and construction considerations".....	41
Re "6.5 Ultimate limit state design".....	41
Re "6.5.1 Overall stability" .....	41
Re "6.5.3 Sliding resistance" .....	42
Re "6.5.4 Loads with large eccentricities" .....	43
Re "6.6 Serviceability limit state design".....	45
Re "6.6.1 General" .....	45
Re "6.6.2 Settlement" .....	45
A 6.6.5 Foundation rotation and limiting a gaping joint .....	45
A 6.6.6 Displacements in the foundation base .....	47
Re "6.7 Foundations on rock; additional design considerations".....	47
Re "6.8 Structural design of spread foundations".....	47
A 6.10 Simplified analysis in standard cases .....	48
A 6.10.1 General.....	48
A 6.10.2 Non-cohesive soil .....	49
A 6.10.3 Cohesive soil .....	53
A 6.10.4 Rock.....	55
A 6.10.5 Artificially placed ground .....	57
Re "7 Pile foundations" .....	57
Re "7.1 General" .....	57
A 7.1.1 Scope and general requirements .....	57
A 7.1.2 Classification into geotechnical categories .....	57
Re "7.2 Limit states" .....	58
Re "7.3 Actions and design situations" .....	58
Re "7.3.1 General" .....	58
Re "7.4 Design methods and design considerations".....	59
Re "7.4.1 Design methods" .....	59
Re "7.4.2 Design considerations" .....	59
Re "7.5 Pile load tests" .....	59
Re "7.5.1 General" .....	59
Re "7.5.3 Dynamic load tests" .....	60
Re "7.5.4 Load test report" .....	60
Re "7.6 Axially loaded piles" .....	60
Re "7.6.3 Ground tensile resistance" .....	66
Re "7.6.4 Vertical displacements of pile foundations (Serviceability of supported structure)" .....	69
Re "7.7 Transversely loaded piles" .....	70
Re "7.7.1 General" .....	70
Re "7.7.2 Transverse load resistance from pile load tests" .....	71
Re "7.7.3 Transverse load resistance from ground test results and pile strength parameters" .....	71
Re "7.8 Structural design of piles" .....	72
Re "7.9 Supervision of construction" .....	72
Re "8 Anchors" .....	72
Re "8.1 General" .....	72
Re "8.1.1 Scope" .....	72
Re "8.1.2 Definitions" .....	72
A 8.1.3 General requirements.....	73

<b>A 8.1.4 Classification into geotechnical categories.....</b>	<b>73</b>
Re “8.2 Limit states” .....	73
Re “8.4 Design and construction considerations” .....	74
Re “8.5 Ultimate limit state design” .....	74
Re “8.5.1 Design of the anchorage” .....	74
Re “8.5.3 Design values of pull-out resistance determined by calculations” .....	75
Re “8.5.4 Structural resistance”.....	75
Re “8.5.5 Design value of the anchorage load” .....	76
A 8.5.6 Verifications of anchor groups.....	76
Re “8.6 Serviceability limit state design” .....	77
Re “8.7 Suitability tests” .....	77
Re “8.8 Acceptance tests” .....	78
Re “8.9 Supervision and monitoring” .....	78
Re “9 Retaining structures” .....	78
Re “9.1 General”.....	78
Re “9.1.1 Scope” .....	78
A 9.1.3 Classification into geotechnical categories.....	78
A 9.1.4 General requirements .....	79
Re “9.2 Limit states” .....	79
Re “9.3 Actions, geometrical data and design situations” .....	79
Re “9.4 Design and construction considerations” .....	80
Re “9.4.1 General” .....	80
Re “9.4.2 Drainage systems” .....	80
Re “9.5 Determination of earth pressures” .....	80
Re “9.5.1 General” .....	80
Re “9.5.5 Compaction effects” .....	81
A 9.5.6 Passive earth pressure .....	82
Re “9.6 Water pressures” .....	82
Re “9.7 Ultimate limit state design” .....	83
Re “9.7.1 General” .....	83
Re “9.7.2 Overall stability” .....	86
Re “9.7.3 Foundation failure of gravity walls” .....	86
Re “9.7.4 Rotational failure of embedded walls” .....	86
Re “9.7.5 Vertical failure of embedded walls” .....	86
Re “9.7.6 Structural design of retaining structures” .....	87
Re “9.7.7 Failure by pull-out of anchors” .....	88
A 9.7.8 Verification of the vertical component of the mobilized passive earth pressure.....	88
A 9.7.9 Failure in the lower failure plane .....	88
A 9.7.10 Failure of slurry trench panels combined with a support fluid .....	88
Re “9.8 Serviceability limit state design” .....	89
Re “9.8.1 General” .....	89
Re “9.8.2 Displacements” .....	90
Re “10 Hydraulic failure” .....	90
Re “10.1 General” .....	90
A 10.1.1 Scope and general requirements.....	90
A 10.1.2 Classification into geotechnical categories .....	90
Re “10.2 Failure by uplift” .....	91
A 10.2.1 General .....	91
A 10.2.2 Verification with coexistent effect of shear forces .....	91
A 10.2.3 Verification of anchored structures.....	92
A 10.2.4 Dimensioning the base.....	92
Re “10.3 Failure by heave” .....	92
Re “10.4 Internal erosion”.....	92
Re “10.5 Failure by piping” .....	93

<b>Re "11 Overall stability" .....</b>	<b>93</b>
<b>Re "11.1 General" .....</b>	<b>93</b>
<b>A 11.1.1 Scope and general requirements .....</b>	<b>93</b>
<b>A 11.1.2 Classification into geotechnical categories .....</b>	<b>93</b>
<b>Re "11.3 Actions and design situations" .....</b>	<b>94</b>
<b>Re "11.4 Design and construction considerations" .....</b>	<b>94</b>
<b>Re "11.5 Ultimate limit state design" .....</b>	<b>94</b>
<b>Re "11.5.1 Stability analysis for slopes" .....</b>	<b>94</b>
<b>Re "11.5.2 Slopes and cuts in rock masses" .....</b>	<b>94</b>
<b>Re "11.5.3 Stability of excavations" .....</b>	<b>95</b>
<b>A 11.5.4 Structural slope revetments .....</b>	<b>95</b>
<b>Re "11.6 Serviceability limit state design" .....</b>	<b>96</b>
<b>Re "12 Embankments" .....</b>	<b>97</b>
<b>Re "12.1 General" .....</b>	<b>97</b>
<b>A 12.1.1 Scope and general requirements .....</b>	<b>97</b>
<b>A 12.1.2 Classification into geotechnical categories .....</b>	<b>97</b>
<b>Re "12.2 Limit states" .....</b>	<b>97</b>
<b>Re "12.3 Actions and design situations" .....</b>	<b>98</b>
<b>A Annex AA (informative) Criteria for examples for classification into geotechnical categories.....</b>	<b>99</b>

## Figures

<b>Figure A 6.1 — Accommodation of a strongly eccentric load by a force couple produced by mobilized passive earth pressure .....</b>	<b>44</b>
<b>Figure A 6.2 — Plan of a rectangular foundation; designations for eccentricity in both axes .....</b>	<b>46</b>
<b>Figure A 6.3 — Design bearing resistance <math>\sigma_{R,d}</math> for square pad foundations on rock .....</b>	<b>56</b>
<b>Figure A 7.1 — Diagram showing the procedure for deriving the correlation factors <math>\xi_5</math> and <math>\xi_6</math> as a function of the calibration according to Table A 7.2 .....</b>	<b>65</b>
<b>Figure A 7.2 — Geometry of the soil block attached to a single pile of a pile group.....</b>	<b>68</b>

## Tables

<b>Table A 2.1 — Partial safety factors <math>\gamma_F</math> or <math>\gamma_E</math> for actions and effects of actions .....</b>	<b>31</b>
<b>Table A 2.2 — Partial safety factors <math>\gamma_M</math> for geotechnical parameters .....</b>	<b>32</b>
<b>Table A 2.3 — Partial safety factors <math>\gamma_R</math> for resistances .....</b>	<b>33</b>
<b>Table A 6.1 — Design bearing resistance <math>\sigma_{R,d}</math> for strip foundations in non-cohesive soil on the basis of adequate bearing capacity and with the prerequisites specified in Table A 6.3 .....</b>	<b>50</b>
<b>Table A 6.2 — Design bearing resistance <math>\sigma_{R,d}</math> for strip foundations in non-cohesive soil on the basis of adequate bearing capacity and limitation of settlement, and with the prerequisites specified in Table A 6.3.....</b>	<b>51</b>

<b>Table A 6.3 — Prerequisites for using the design bearing resistance <math>\sigma_{R,d}</math> as in Tables A 6.1 and A 6.2 for non-cohesive soil.....</b>	<b>51</b>
<b>Table A 6.4 — Prerequisites for increasing the design bearing resistance <math>\sigma_{R,d}</math> as in A 6.10.2.2 A (3) for non-cohesive soil .....</b>	<b>52</b>
<b>Table A 6.5 — Design bearing resistance <math>\sigma_{R,d}</math> for strip foundations with widths <math>b</math> or <math>b'</math> of 0,50 m to 2,00 m in silt (soil group UL as in DIN 18196) of stiff to very stiff consistency or with a mean unconfined compression strength <math>q_{u,k}</math> of &gt; 120 kN/m<sup>2</sup>.....</b>	<b>53</b>
<b>Table A 6.6 — Design bearing resistance <math>\sigma_{R,d}</math> for strip foundations on mixed grained soils (SU*, ST, ST*, GU*, GT* as in DIN 18196; e.g. boulder clay) with widths <math>b</math> or <math>b'</math> of 0,50 m to 2,00 m .....</b>	<b>53</b>
<b>Table A 6.7 — Design bearing resistance <math>\sigma_{R,d}</math> for strip foundations with widths <math>b</math> or <math>b'</math> of 0,50 m to 2,00 m on clayey, silty soils (soil group UM, TL, TM as in DIN 18196) .....</b>	<b>54</b>
<b>Table A 6.8 — Design bearing resistance <math>\sigma_{R,d}</math> for strip foundations on clay soil (TA as in DIN 18196) with widths <math>b</math> or <math>b'</math> of 0,50 m to 2,00 m .....</b>	<b>54</b>
<b>Table A 7.1 — Correlation factors <math>\xi_i</math> for determining characteristic values from static pile load tests.....</b>	<b>61</b>
<b>Table A 7.2 — Basic values <math>\xi_{0,i}</math> with associated margins and model factors for correlation factors <math>\xi_5</math> and <math>\xi_{90c6}</math> for deriving characteristic values from impact tests or dynamic pile load tests .....</b>	<b>64</b>
<b>Table A 8.1 — Testing or analysis for verification of pull-out resistance.....</b>	<b>75</b>
<b>Table A 9.1 — Magnitude of the negative earth pressure inclination angle for verifications against failure due to settlement.....</b>	<b>87</b>
<b>Table AA.1 — Criteria and examples for classification into geotechnical categories.....</b>	<b>100</b>