Singapore Standard SS EN 1997-1 : 2010 (2018)

Eurocode 7: Geotechnical design – Part 1: General rules

AMENDMENT NO. 1

January 2018

1. Page 3, Contents

Replace "Section 8 Anchorages" with "Section 8 Anchors".

2. Page 8, National annex for EN 1997-1, Paragraph 2

Replace "8.5.2(2)P, 8.5.2(3), 8.6(4)" with "8.4(6)P, 8.4(7)P, 8.5.1 (1)P, 8.5.1 (2)P, 8.5.2(1)P, 8.5.2(2)P, 8.5.2(3)P, 8.5.2(5)P, 8.5.3(1)P, 8.5.3(2)P, 8.5.3(3)P, 8.5.3(4)P, 8.6.2(2)P, 8.6.2(3)P".

Replace "A.3.1, A.3.2, A.3.3.1, A.3.3.2, A.3.3.3, A.3.3.4, A.3.3.5, A.3.3.6" with "A.3.1, A.3.2, A.3.3.1, A.3.3.2, A.3.3.3, A.3.3.5, A.3.3.6".

Add "– A.6" after "– A.5".

3. Page 9, 1.1.2 (2), Scope of EN 1997-1

Replace "Section 8: Anchorages" with "Section 8: Anchors".

4. Page 10, 1.2, Normative references

Add "EN 1992-1-1:2004 Eurocode 2: Design of concrete structures – Part 1-1: General rules and rules for buildings" after "EN 1992 Eurocode 2 Design of concrete structures".

Replace "EN 1537:1999 Execution of special geotechnical work; Ground anchors" with "EN 1537 Execution of special geotechnical work; Ground anchors".

Add "EN ISO 22477-5 Geotechnical investigation and testing – Testing of geotechnical structures – Part 5: Testing of anchors (in preparation)" after "EN ISO 13793:2001 Thermal performance of buildings – Thermal design of foundations to avoid frost heave".

5. Page 14, 1.6 Symbols

Delete the following:

P	load on anchorage
P_p	proof load in a suitability test of a grouted anchorage
R_a	anchorage pull-out resistance
$R_{a;d}$	design value of R_a
$R_{a;k}$	characteristic value of R_a
γ_a	partial factor for anchorages
$\gamma_{a;p}$	partial factor for permanent anchorages
$\gamma_{a;t}$	partial factor for temporary anchorages
ξ_a	correlation factor for anchorages

Replace "$R_{t;d}$ design value of the tensile resistance of a pile or of a group of piles, or of the structural tensile resistance of an anchorage" with "$R_{t;d}$ design value of the tensile resistance of a pile or of a group of piles".

Add the following new text after "z vertical distance":

Latin letters used in Section 8

$E_{ULS;d}$ ultimate limit state design force to be resisted by the anchor

$F_{Serv;d}$ design value of the maximum anchor force, including effect of lock off load, and sufficient to prevent a serviceability limit state in the supported structure

$(R_{SLS;m})_{min}$ lowest value of $R_{SLS;m}$ measured from a number of investigation or suitability tests (*n*), for each distinct ground condition

$R_{t;d}$ ultimate limit state design resistance of the structural elements of an anchor

$R_{ULS;d}$ design value of the resistance of an anchor complying with ultimate limit state criteria

$R_{ULS;k}$

$F_{Serv;k}$ characteristic value of the maximum anchor force, including effect of lock off load, and sufficient to prevent a serviceability limit state in the supported structure

$F_{ULS;d}$ design value of the force required to prevent any ultimate limit state in the supported structure

$k_{l;SLS}$ permissible cumulative loss of load over specified time period, defined in EN ISO 22477-5, used to determine serviceability limit state resistance of an anchor

$k_{l;ULS}$ permissible cumulative loss of load over specified time period, defined in EN ISO 22477-5, used to determine ultimate limit state resistance of an anchor

n minimum number of investigation and/or suitability tests

P_c the critical creep load, determined as the load corresponding to the end of the pseudo linear part of the *a* versus load diagram as defined in EN ISO 22477-5

P_o lock-off load, load left in the anchor head immediately on completion of the stressing operation

P_p proof load, maximum test load to which an anchor is subjected in a particular load test

R_m measured value of the resistance of an anchor

$R_{SLS;d}$ design value of the resistance of an anchor complying with serviceability limit state criteria

$R_{SLS;k}$ characteristic value of the resistance of an anchor complying with serviceability limit state criteria

$R_{SLS;m}$ measured value of the resistance of an anchor complying with serviceability limit state criteria

characteristic value of the resistance of an anchor complying with ultimate limit state criteria

$R_{ULS;m}$ measured value of the resistance of an anchor complying with ultimate limit state criteria

$(R_{ULS;m})_{min}$ lowest value of $R_{ULS;m}$ measured from a number of investigation or suitability tests (*n*), for each distinct ground condition

Add the following after "φ'_d design value of φ' ":

Greek letters used in Section 8

α_{SLS} creep rate defining serviceability limit state resistance of an anchor, determined from the displacement per log cycle of time at constant anchor load as defined in EN ISO 22477-5

α_{ULS} creep rate defining ultimate limit state resistance of an anchor, determined from the displacement per log cycle of time at constant anchor load as defines in EN ISO 22477-5

γ_{Serv} , $\gamma_{a;ULS}$, $\gamma_{a;SLS}$, $\gamma_{a;acc;ULS}$, $\gamma_{a;acc;SLS}$ partial factors

ξ_{ULS} correlation factor

6. Page 91, Section 8, Anchorages

Replace the entire text of Section 8, including the title with the following:

Section 8 Anchors

8.1 General

8.1.1 Scope

(1)P This Section shall apply to the design of temporary and permanent anchors used e.g.:

- to support a retaining structure;
- to ensure the stability of slopes, cuts or tunnels;
- to resist uplift forces on a structure;
- to prevent sliding or tilting;
- to restrain tension cables;

by transmitting a tensile force to a load resisting formation of soil or rock.

(2)P This section shall be used for the design of anchors covered by EN 1537 and other anchors that are consistent with 8.1.2.1, such as screw anchors and expander anchors with a free length.

(3)P Tension members without a free length (such as tension piles) shall be designed using the principles given in Section 7 'Pile foundations'.

(4)P Walls providing fixity for dead-man anchors shall be designed using the principles given in Section 9, 'Retaining structures'.

(5) This section does not cover the design of soil nails or rock bolts.

8.1.2 Definitions

8.1.2.1
anchor
installation capable of transmitting an applied tensile load through a free length to a load bearing stratum

8.1.2.2
grouted anchor
anchor that uses a bonded length formed of cement grout, resin or similar material to transmit the tensile force to the ground

NOTE A 'grouted anchor' in EN 1997-1 is termed a 'ground anchor' in EN 1537.

8.1.2.3
permanent anchor
anchor with a design life which is in excess of two years

8.1.2.4
temporary anchor
anchor with a design life of 2 years or less

8.1.2.5
tendon
part of an anchor that is capable of transmitting the tensile load from the anchor head to the resisting element in the ground

8.1.2.6
anchor fixed length
designed length of an anchor over which the load is transmitted to the surrounding ground

8.1.2.7
anchor free length
length of the anchor between the anchorage point at the anchor head and the proximal end of the anchor fixed length

8.1.2.8
tendon bond length for grouted anchors
length of the tendon that is bonded directly to the grout and capable of transmitting the applied tensile load

8.1.2.9
tendon free length
length of the tendon between the anchorage point at the anchor head and the proximal end of the tendon bond length

8.1.2.10
apparent tendon free length
length of tendon which is estimated to be fully decoupled from the surrounding grout and is calculated from the load-elastic displacement data following testing

8.1.2.11
investigation test
load test to establish the geotechnical ultimate resistance of an anchor and to determine the characteristics of the anchor in the working load range

8.1.2.12
suitability test
load test to confirm that a particular anchor design will be adequate in particular ground conditions

8.1.2.13
acceptance test
load test to confirm that an individual anchor conforms with its acceptance criteria

8.2 Limit states

(1)P The following limit states (both individually and in combination) shall be considered for all anchors:

- Structural failure of the tendon or anchor head, caused by the applied stresses;
- failure of the connection between the tendon and the resisting element in the ground;
- loss of anchor force and excessive displacements of the anchor head due to creep and relaxation;
- failure or excessive deformation of parts of the anchored structure due to the applied anchor force;
- loss of overall stability of the retained ground and the retaining structure (see Section 11);
- limit states in supported or adjacent structures, including those arising from pre-stressing forces;
- instability or excessive deformation of the zone of ground into which tensile forces from a group of anchors are to be transferred;
- failure at the interface between the resisting element and the ground.

(2)P In addition to the limit states listed in 8.2(1)P, the following limit states (both individually and in combination) shall be considered for all grouted anchors:

- failure at the interface between the body of grout and the ground;
- failure of the bond at the interfaces of tendon, encapsulation and grout;
- failure of the bond between the tendon and the grout.

(3) For a group of anchors, the most critical failure surface should be considered.
NOTE Depending on spacing and the profile of ground strength, this can involve displacement of part or all of the block contained by the anchors, often combined with pull-out of the distal ends of the anchors.

8.3 Design situations and actions

(1)P Design situations shall be selected in accordance with 2.2.

(2)P In addition, consideration shall be given to:

- All pertinent limit states listed in 8.2 and their combinations;
- chemical components of ground and ground water that can adversely affect the durability of the anchor.

(3)P The design value of the anchor load shall be derived from the design of the anchored structure, taking into consideration ultimate and serviceability limit states.

8.4 Design and construction considerations

(1)P Anchors shall out be used unless their design and construction have been verified by investigation or suitability tests in accordance with EN ISO 22477-5 or by comparable experience (as defined in 1.5.2.2) and have been shown to have the required performance and durability, which have been documented.

(2)P Account shall be taken of the effects of any deformations imposed on adjacent structures when installing the anchor and by the anchor pre-stress force.

(3) The zone of ground into which tensile forces are to be transferred should be included in site investigations whenever possible.

(4)P For pre-stressed anchors, the anchor head shall be designed to allow the tendon to be stressed, proof-loaded and locked off and, if required, released, de-stressed and re-stressed.

(5)P The anchor head shall be designed to tolerate angular deviations of the anchor force, and to be able to accommodate deformations that can occur during the design life of the structure.

(6)P Since the effectiveness of an anchor depends on its free length, the anchor force shall act in ground that is sufficiently distant from the anchored structure such that no additional force is applied on it. The necessary anchor free length shall be determined in the design of the anchored structure.

NOTE The method of determining the necessary free length may be set in the National Annex.

(7)P Measures shall be taken to avoid adverse interactions between anchors that are located close to each other.

NOTE The criteria for the necessity to check the group effects may be set in the National Annex.

(8)P The direction of the anchor should normally be chosen to enable self-stressing under deformation. If this is not feasible, the adverse effects of potential failure mechanisms shall be taken into account.

(9)P A sufficient lock-off force shall be used to ensure that the anchor resistance under serviceability limit state conditions will be mobilised with tolerable head displacements.

(10) If the anchor is analysed as a spring, its stiffness should be selected to achieve compatibility between calculated displacements of the retained structure and the displacement and elongation of the anchor, including displacement of the fixed anchor length.

(11)P Corrosion protection of anchors that have a tendon made of steel shall be designed taking into account the type of steel and the aggressiveness of the ground environment.

(12)P For grouted anchors, corrosion protection shall be in accordance with EN 1537.

8.5 Limit state design of anchors

8.5.1 General

(1)P The design value of the geotechnical ultimate limit state resistance of an anchor, $R_{ULS;d}$, shall satisfy the following inequality:

$$E_{ULS;d} \leq R_{ULS;d} \quad (8.1)$$

where:

$$E_{ULS;d} = \max (F_{ULS;d} ; F_{Serv;d}) \quad (8.2)$$

and where:

$$F_{Serv;d} = \gamma_{Serv} \times F_{Serv;k} \quad (8.3)$$

NOTE 1 The value of partial factor γ_{Serv} may be set by the National Annex. The recommended value for persistent and transient situations is given in Table A.18.

NOTE 2 Formulae (8.1) to (8.3) are also applicable to uplift calculations (UPL).

NOTE 3 It is assumed in Section 8 that all partial factors and correlations factors for serviceability limit states are unity unless symbols are specifically included. The values for additional partial factors and correlation factors for serviceability limit states may be set in National Annex.

(2)P When a separate evaluation of the serviceability limit state of the anchor is required the evaluation shall be carried out using Formula (8.4).

$$F_{Serv;k} \leq R_{SLS;d} \quad (8.4)$$

NOTE 1 The National Annex may set whether a separate evaluation of the serviceability limit state of the anchor is required.

NOTE 2 The National Annex may set whether the verifications for ultimate limit state and serviceability limit state are to be carried out separately or in a combined procedure.

8.5.2 Geotechnical ultimate limit state resistance

(1)P The measured geotechnical ultimate limit state resistance of an anchor as defined in 8.5.2(2) P shall be determined from a number of investigation or suitability tests (n) carried out in accordance with EN ISO 22477-5.

NOTE The test method to be used to determine the measured resistance and the number of tests n may be set in the National Annex.

(2)P The measured ultimate limit state resistance of an anchor $R_{ULS;m}$ shall be determined by load tests as the lesser of the proof or the load causing a limiting condition (R_m). The limiting condition depends on the test method and may be:

- the asymptote to the creep rate versus load curve, or;
- the load corresponding to a limit value of the creep rate (α_{ULS}), or;
- the load corresponding to a limit value of load loss ($K_{I;ULS}$).

Thus:

$$R_{ULS;m} = \min \{R_m \ (\alpha_{ULS} \text{ or } K_{I;ULS}) \text{ and } P_p\} \quad (8.5)$$

NOTE The limit value of the creep rate (α_{ULS}) or load loss ($K_{I;ULS}$) may be set by the National Annex, which may specify the use of an asymptote to the creep rate versus load curve in place of a specified value for GTULS- Recommended values for persistent and transient situations are given in Table A.21.

(3)P The characteristic value of the ultimate limit state geotechnical resistance of an anchor, $R_{ULS;k}$, shall be derived from:

$$R_{ULS;k} = \frac{(R_{ULS;m})min}{\xi ULS} \quad (8.6)$$

NOTE 1 Values of the correlation factor ξ_{ULS} may be set by the National Annex. Recommended values for persistent and transient situations are given in Table A.20.

NOTE 2 The minimum number of investigation and suitability tests n to be carried out to determine $(R_{ULS;m})$min may be set by the National Annex. Recommended values for persistent and transient situations are given in Table A.20.

(4) Investigation tests should normally be loaded to the estimated ultimate resistance of the ground/grout interface and may require tendons and other structural components of greater capacity than used in suitability or acceptance tests.

(5)P The design value of the geotechnical ultimate limit state resistance of an anchor shall be derived from:

$$R_{ULS;d} = \frac{R_{ULS;k}}{\gamma_{a;ULS}} \quad (8.7)$$

NOTE The value of the partial $\gamma_{a;ULS}$ may be set by the National Annex. Recommended values for persistent and transient are given in Table A.19.

8.5.3 Geotechnical serviceability limit state resistance

(1)P The measured geotechnical serviceability limit state resistance of an anchor as defined in 8.5.3(2) P shall be determined from a number of investigation and/or suitability tests (n) carried out in accordance with EN ISO 22477-5.

NOTE 1 The test method to be used to determine the measured resistance and the number of test n may be set in the National Annex.

NOTE 2 The test method to be used to determine the measured resistance may be set in the National Annex

(2)P The measured geotechnical serviceability limit state of a test anchor $R_{SLS;m}$ shall be determined by investigation tests or suitability tests as the lesser of the proof load or the load causing a limiting condition. The limiting condition depends on the test method and is the critical creep load (P_c) or the load corresponding to a limit value of the creep rate (α_{SLS}) or load loss ($k_{l;SLS}$). Thus:

$$R_{SLS;m} = \min \{ R_m (\alpha_{SLS} \text{ or } k_{l;SLS} \text{ or } P_c) \text{ and } P_p\} \quad (8.8)$$

NOTE The limit value of the creep rate (α_{SLS}) or load loss ($k_{l;SLS}$) or P_c may be set by the National Annex. Recommended values are given in Table A.21.

(3)P The characteristic value of the serviceability anchor resistance ($R_{SLS;k}$) shall be derived from:

$$R_{SLS;k} = (R_{SLS;m})\min \quad (8.9)$$

NOTE The minimum number of investigation and suitability tests *n* to be carried out to determine $(R_{SLS;m})_{min}$ may be set by the National Annex. Recommended values are given in Table A.20.

(4)P The design value of the serviceability limit state anchor resistance shall be derived from:

$$R_{SLS;d} = \frac{R_{SLS;k}}{\gamma_{a;SLS}} \quad (8.10)$$

NOTE The value of the partial factor $\gamma_{a;SLS}$ may be set by the National Annex. The recommended values are in given in Table A.20.

8.5.4 Structural resistance

(1)P The ultimate limit state design resistance of the structural elements of an anchor, $R_{t;d}$, shall be calculated according to the structural Eurocodes, e.g. EN 1992 and EN 1993 as relevant, to satisfy the inequality:

$$E_{ULS;d} \leq R_{t;d} \quad (8.11)$$

(2)P The structural design of an anchor under a proof load shall comply with 5.10.2.1 from EN 1992-1-1:2004.

(3) For grouted anchors, the tendon/grout resistance of the anchor shall comply with the relevant standards, for example EN 1992-1-1 and EN 1537.

NOTE ETAG 013 *Guideline for European Technical Approval of post-tensioning kits for prestressing of structures,* Eota, Brussels, edition: June 2002, may be applicable.

8.6 Tests on anchors

8.6.1 Investigation or suitability tests

(1)P In order to satisfy the requirements of 8.5.1, investigation or suitability tests carried out in accordance with EN ISO 22477-5 shall be undertaken to verify that limiting criteria are not exceeded at a proof load $P_{p,}$ given by:

$$P_p \geq \xi_{ULS} \times \gamma_{a;ULS} \times E_{ULS;d} \quad (8.12)$$

(2) Grouted anchors with tendon bond lengths spaced at less than 1.5 m should be tested in groups unless comparable experience has shown that the interaction has quantifiable effects which can be taken into account.

8.6.2 Acceptance tests

(1)P Acceptance tests shall be carried out in accordance with EN ISO 22477-5 on all grouted anchors prior to their lock off and before they become operational.

(2)P The proof load, P_p, to be applied to the anchor in an acceptance test shall be derived from the ultimate limit state design force $E_{ULS;d}$ or from $F_{Serv;k}$ using the following inequalities:

$$P_p \geq \gamma_{a;acc;ULS} \times E_{ULS;d} \quad (8.13)$$

or:

$$P_p \geq \gamma_{a;acc;SLS} \times F_{Serv;k} \quad (8.14)$$

NOTE 1 The value of the partial factors $\gamma_{a;acc;ULS}$ and $\gamma_{a;acc;SLS}$ may be set by the National Annex. Recommended values of $\gamma_{a;acc;ULS}$ for persistent and transient situations and for $\gamma_{a;acc;SLS}$ are given in Table A.20.

NOTE 2 The National Annex may state whether the proof load in an acceptance test is to be related to the ultimate limit state design force (8.13) or to $F_{Serv;k}$ (8.14).

(3)P For each test, the creep rate/load loss that occurs under the proof load and under other specified loads not exceeding limit values.

NOTE 1 The limiting values for creep rate/load loss at proof load may be set by the National Annex. Recommended values for persistent and transient situations are given in Table A.21.

NOTE 2 The requirement to check creep rate/load loss at other specified loads, less than the proof load, is optional and may be set by the National Annex. No recommended values are provided.

(4)P The apparent free length of a grouted anchor shall comply with the requirements in EN 1537.

8.7 Lock-off load for pre-stressed anchors

(1)P The lock-off load shall be sufficient to ensure serviceability of the structure and supporting structures.

(2)P The lock-off load shall not give rise to a limit state in the ground, in the structure or in supporting structures.

(3) For grouted anchors, where tendon bond lengths of a group of anchors cross at spacings less than 1.5 m (centre to centre), the pre-stress should be checked on selected anchors after completion of the lock-off process.

8.8 Supervision, monitoring and maintenance

(1) Supervision, monitoring and maintenance should follow the rules given in Section 4 of this standard and in EN 1537, where appropriate.

7. Page 97 Section 9

9.1.2.2 *Replace* “anchorages” with “anchors”.

9.1.2.3 *Replace* “anchorages” with “anchors”.

9.2(1)P *Replace “*anchorage” with “anchor”.

9.4.1(8) P *Replace* “anchorages” with “anchors” (2 x).

9.5.3(3) *Replace* “anchorages” with “anchors”.

9.7.5(3)P *Replace* “anchorages” with “anchors”.

9.7.6(1)P *Replace* “anchorages” with “anchors”.

9.7.7 Title *Replace* “anchorages” with “anchors”.

9.7.7(1)P *Replace* “anchorages” with “anchors”.

8. Page 113, 10.2

Figure 10.1 e) *Replace* “9 anchorage” with “9 anchor”.

10.2(5)P *Replace “*anchorages” with “anchors”.

9. Page 118, 11.4, 11.4(10)

Replace “anchorage” with “anchors”.

10. Page 128, Annex A (normative)

Replace the title of Annex A with **“**Partial and correlation factors for ultimate and serviceability limit states and recommended values”.

A.1 Partial factors and correlation factors

Replace the text of A.1 (1)P with :

(1)P The partial factors ɣ for ultimate limit states in persistent and transient design situations shall be those mentioned in this annex.

(2)P The partial factors ɣ for serviceability limit states for anchors shall be those mentioned in this annex.

(3)P The correlation factors ξ for pile foundations and anchors in all design situations shall be those mentioned in this annex.

11. Page 134, A.3.3.4

Replace the title with "Partial resistance factors for anchors".

A.3.3.4(1)P

Replace entire text with: "(1) See A.6.".

Replace the title of Table A.12 with "Table A.12 – Not used".

Delete Table A.12.

12. Page 136, A.4

A.4(2)P

Replace:

– γ_a on anchorage resistance.

NOTE The values to be ascribed to $\gamma_{\varphi'}$, $\gamma_{c'}$, γ_{cu}, $\gamma_{s;t}$ and γ_a for use in a country may be found in its National Annex to this standard. The recommended values are given in Table A.16.

with:

– $\gamma_{a;ULS}$ on ultimate limit state anchor resistance

NOTE The values to be ascribed $\gamma_{\varphi'}$, $\gamma_{c'}$, γ_{cu}, $\gamma_{s;t}$ and $\gamma_{a;ULS}$ for use in a country may be found in its National Annex to this standard. The recommended values are given in Table A.16.

Replace Table A.16 with:

Table A.16 – Partial factors for soil parameters and resistances

Soil parameter	**Symbol**	**Value**
Angle of shearing resistance [a]	$\gamma_{\varphi'}$	1,25
Effective cohesion	$\gamma_{c'}$	1,25
Undrained shear strength	γ_{cu}	1,40
Tensile pile resistance	$\gamma_{s;t}$	1,40
Ultimate limit state anchor resistance	$\gamma_{a;ULS}$	[b]

[a] This factor is applied to tan φ'

[b] See Table A.19

13. Page 135, A.5

Add after the full text of A.5 (1)P the following text:

A.6 Partial resistance factors, correlation factors, limiting criteria for ultimate and serviceability limit states, and number of investigation/suitability tests for anchors

(1)P For the verification of actions and action effects for persistent and transient design situations at the ultimate limit state and for serviceability limit states the following partial factor shall be applied:

– γ_{Serv} on $F_{Serv;k}$

NOTE The values to be ascribed to γ_{Serv} for use in a country may be found in its National Annex to this standard. The recommended values are given in Table A.18.

Table A.18 – Partial factors on actions and action effects for persistent and transient design situations at the ultimate limit state

Limit state	**Symbol**	**Value**
Ultimate (Formula 8.3)	γ_{Serv}	1,35
NOTE the recommended value of γ_{Serv} applies to all Design Approaches		

(2)P For the verification of anchors in ultimate limit states STR, GEO, and UPL in persistent and transient design situations, the following partial factor shall be applied:

– $\gamma_{a;ULS}$ on $R_{ULS;k}$

NOTE The values to be ascribed to $\gamma_{a;ULS}$ for use in a country may be found in its National Annex to this standard. The recommended values are given in Table A.19.

Table A.19 – Partial resistance factors (γ_R) for anchors in ultimate limit state for persistent and transient design situations

Symbol	**STR/GEO set**				**UPL**
	R1	**R2**	**R3**	**R4**	
$\gamma_{a;ULS}$	**1,1**	**1,1**	**1,0**	**1,1**	**1,4**

(3)P For the verification of anchor test methods for persistent and transient design situations at the ultimate limit state and for serviceability limit states the following correlation and partial factors shall be applied:

– ξ_{ULS} on $(R_{ULS;m})_{min}$;

– $\gamma_{a;SLS}$ on $R_{SLS;k}$;

– $\gamma_{a;acc;ULS}$ on $E_{ULS;d}$;

– $\gamma_{a;acc;SLS}$ on $F_{Serv;k}$.

NOTE The values to be ascribed to ξ_{ULS}, $\gamma_{a;SLS}$, $\gamma_{a;acc;ULS}$ and $\gamma_{a;acc;SLS}$ for use in a country may be found in its National Annex to this standard. The recommended values are given in Table A.20.

Table A.20 – Values depending on anchor test method for persistent and transient design situations at the ultimate limit state and for serviceability limit states

Symbol	Equation	Test method [a]		
		1	**2**	**3**
ξ_{ULS}	8.6	1,0[b]	1,0[b]	1,0
$\gamma_{a;SLS}$	8.10	NA	1,0	1,2[c]
n		3	3	2
$\gamma_{a;acc;ULS}$	8.13	1,1	1,1	NA
$\gamma_{a;acc;SLS}$	8.14	NA	1,0	1,25[c]
NOTE NA = Not Applicable				
[a] For a description of the test methods see EN ISO 22477-5. [b] This value applies provided acceptance tests on every anchor (proof load to Formula 8.13) give assurance that EULS;d ≤ RULS;d. The value of ξ_{ULS} to be used when this is not the case may be set by the National Annex. [c] Values given are for permanent anchors.				

(4)P For the verification of investigation, suitability and acceptance tests for persistent and transient design situations at the ultimate limit state and for serviceability limit states, the anchor shall satisfy limiting criteria.

NOTE The limiting criteria for use in a country may be found in its National Annex to this standard. The recommended values are given in Table A.21.

Table A.21 – Limiting criteria for investigation, suitability and acceptance tests for persistent and transient design situations at the ultimate and serviceability limit states

Test method [a]	Limiting criterion	Investigation and suitability tests		Acceptance tests	
		ULS (Formula 8.5)	**SLS** (Formula 8.8)	**ULS** (Formula 8.13)	**SLS** (Formula 8.14)
1	α_1	2 mm	0,01Δe [c]/NA [d]	2 mm	0,01 Δe [c]/NA [d]
2 [b]	K_1	2 % per log cycle of time	2 % per log cycle of time	2 % per log cycle of time	2 % per log cycle of time
3	α_3	5 mm	NA (use P_c)	NA	1,5 mm [e]
NOTE NA = Not Applicable					
[a] For a description of the test methods see EN ISO 22477-5. [b] Times of observation for load loss in accordance with Table H.1, Annex H, EN ISO 22477-5 [c] Δe = ($F_{serv;k}$ x tendon free length) / (area of tendon x elastic modulus of tendon) [d] Value is only applicable when SLS-testing is undertaken [e] Value given is for permanent anchors; for temporary anchors, α_3 = 1.8 mm					

14. Page 140, B.3 (5)

Replace “anchorages” with “anchors”.