DS/EN 1998-1 DK NA:2020

National Annex to

Eurocode 8: Design of structures for earthquake resistance - Part 1: General rules, seismic actions and rules for buildings

Foreword

This National Annex (NA) DS/EN 1998-1 DK NA:2020 is the first Danish national annex to EN 1998-1.
During the period until 2020-07-01, a_{seis} in D.5 of Annex D may be taken as 1,5 % of g. From 2020-07-01 this Annex shall be applied.

This NA lays down the conditions for the implementation in Denmark of EN 1998-1 for construction works in conformity with the Danish Building Regulations.

The values of actions in DS/EN 1990 DK NA:2013 will be replaced by this National Annex DS/EN 1998-1 DK NA:2020.

An NA contains national provisions, viz. nationally applicable values or selected methods. The NA may furthermore give non-contradictory, complementary information.

This NA includes:

- an overview of possible national choices and clauses containing complementary information;

- national choices;
- non-contradictory, complementary information.

This DK NA deviates from other Danish NAs as either Annex D of this DK NA or DS/EN 1998-1 can be used together with the rest of this DK NA.

Overview of possible national choices and complementary information

The list below identifies the clauses where national choices are possible and the applicable/not applicable informative annexes.
Furthermore, clauses giving complementary information are identified. Complementary information is given at the end of this National Annex.

Clause	**Subject**	**National choice[1)]**	**Complementary information**
1.1.2(7)	Informative Annexes A and B.	Unchanged	
2.1(1)P Note 1	Reference return period T_{NCR} of seismic action for the no-collapse requirement (or, equivalently, reference probability of exceedance in 50 years, P_{NCR}).	Unchanged	
2.1(1)P Note 2	Reference return period T_{DLR} of seismic action for the damage limitation requirement (or, equivalently, reference probability of exceedance in 10 years, P_{DLR}).	Unchanged	
3.1.1(4)	Conditions under which ground investigations additional to those necessary for design for non-seismic actions may be omitted and the usual standard ground classification may be used.	Knowledge about the ground shall be sufficient for classification in accordance with Table 3.1 DK NA.	If there is any doubt about which ground type is to be selected, then the most unfavourable type shall be selected.
3.1.2(1)	Ground classification scheme accounting for deep geology, including values of parameters S, T_B, T_C and T_D defining horizontal and vertical elastic response spectra in accordance with 3.2.2.2 and 3.2.2.3.	Ground types A, B, C, D, E, S_1 and S_2 are identified using Table 3.1 DK NA. The values of the parameters S, T_B, T_C and T_D are unchanged from EN 1998-1.	

Clause	Subject	National choice[1)]	Complementary information
3.2.1(1), (2),(3)	Seismic zone maps including reference ground accelerations.	Figure D.2 DK NA in Annex D to this NA shows a map of design ground accelerations on ground type A with a return period of 475 years for Denmark.	
3.2.1(4)	Governing parameter (identification and value) for threshold of low seismicity.	As an alternative to the application of EN 1998-1, Annex D to this NA may be used for all types of structures, ground types and seismic zones.	
3.2.1(5)P	Governing parameter (identification and value) for threshold of very low seismicity.	Not applicable.	
3.2.2.1(4) 3.2.2.2(2)P	Parameters S, T_B, T_C, T_D defining shape of horizontal elastic response spectra.	Unchanged	
3.2.2.3(1)P	Parameters a_{vg}, T_B, T_C, T_D defining shape of vertical elastic response spectra.	Unchanged	
3.2.2.5(4)P	Lower bound factor β on design spectral values.	Unchanged	
4.2.3.2(8)	Reference to definitions of centre of stiffness and of torsional radius in multi-storey buildings meeting or not meeting conditions (a) and (b) of 4.2.3.2(8).	Unchanged	
4.2.4(2)P	Values of φ for buildings.	Unchanged	

Clause	Subject	National choice[1)]	Complementary information
4.2.5(5)P	Importance factor γ_I for buildings. Importance factor in EN 1998-1 is referred to as seismic class in the Danish NA.	Use γ_I values defined in Annex D, DK NA.	
4.3.3.1 (4)	Decision on whether nonlinear methods of analysis may be applied for the design of non-base-isolated buildings. Reference to information on member deformation capacities and the associated partial factors for the Ultimate Limit State for design or evaluation on the basis of nonlinear analysis methods.	Not relevant.	
4.3.3.1 (8)	Threshold value of importance factor, γ_I, relating to the permitted use of analysis with two planar models.	Unchanged	γ_I is denoted "seismic factor" in Annex D;
4.4.2.5(2)	Overstrength factor γ_d for diaphragms.	Unchanged	
4.4.3.2 (2)	Reduction factor v for displacements at damage limitation limit state.	Unchanged	
5.2.1(5)P	Geographical limitations on use of ductility classes for concrete buildings.	Unchanged	
5.2.2.2(10)	q_o value for concrete buildings subjected to special Quality System Plan.	Unchanged	
5.2.4 (3)	Material partial factors for concrete buildings in the seismic design situation.	Unchanged	
5.4.3.5.2(1)	Minimum web reinforcement of large lightly reinforced concrete walls	Unchanged	
5.8.2(3)	Minimum cross-sectional dimensions of concrete foundation beams.	Unchanged	
5.8.2(4)	Minimum thickness and reinforcement ratio of concrete foundation slabs.	Unchanged	
5.8.2(5)	Minimum reinforcement ratio of concrete foundation beams.	Unchanged	
5.11.1.3.2(3)	Ductility class of precast wall panel systems.	Unchanged	

Clause	**Subject**	**National choice[1)]**	**Complementary information**
5.11.1.4	Reduction factors k_p of behavior factors of prefabricated systems.	Unchanged	
5.11.1.5(2)	Seismic action during erection of prefabricated structures.	Unchanged	
5.11.3.4(7)e	Minimum longitudinal steel in grouted connections of large panel walls.	Unchanged	
6.1.2(1)P	Upper limit of q for low-dissipative structural behaviour; limitations on structural behaviour concept; geographical limitations on use of ductility classes for steel buildings.	Unchanged	
6.1.3(1)	Material partial factors for steel buildings in the seismic design situation.	Unchanged	
6.2(3)	Overstrength factor for capacity design of steel buildings.	Unchanged	
6.2 (7)	Information as to how EN 1993-1-10:2005 may be used in the seismic design situation.	Unchanged	
6.5.5(7)	Reference to complementary rules on acceptable connection design.	Unchanged	
6.7.4(2)	Residual post-buckling resistance of compression diagonals in steel frames with *V*-bracings.	Unchanged	
7.1.2(1)P	Upper limit of q for low-dissipative structural behaviour; limitations on structural behaviour concept; geographical limitations on use of ductility classes for composite steel-concrete buildings.	Unchanged	
7.1.3(1), (3)	Material partial factors for composite steel-concrete buildings in the seismic design situation.	Unchanged	
7.1.3(4)	Overstrength factor for capacity design of composite steel-concrete buildings.	Unchanged	

Clause	**Subject**	**National choice[1)]**	**Complementary information**
7.7.2(4)	Stiffness reduction factor for concrete part of a composite steel-concrete column section.	Unchanged	
8.3(1)P	Ductility class for timber buildings.	Unchanged	
9.2.1(1)	Type of masonry units with sufficient robustness.	All.	
9.2.2(1)	Minimum strength of masonry units.	Unchanged	
9.2.3(1)	Minimum strength of mortar in masonry buildings.	Unchanged	
9.2.4(1)	Alternative classes for perpend joints in masonry.	Unchanged	
9.3(2)	Conditions for use of unreinforced masonry satisfying provisions of EN 1996 alone.	Unchanged	
9.3(3)	Maximum value of ground acceleration for the use of unreinforced masonry satisfying provisions of EN 1998-1.	Unchanged	
9.3(4), tabel 9.1	*q*-factor values in masonry buildings.	Unchanged	
9.3(4), tabel 9.1	*q*-factors for buildings with masonry systems which provide enhanced ductility.	Unchanged	
9.5.1(5)	Geometric requirements for masonry shear walls.	Unchanged	
9.6(3)	Material partial factors in masonry buildings in the seismic design situation.	Unchanged	
9.7.2(1)	Maximum number of storeys and minimum area of shear walls walls of "simple masonry building".	Unchanged	
9.7.2(2)b	Minimum aspect ratio in plan of “simple masonry buildings”.	Unchanged	
9.7.2(2)c	Maximum floor area of recesses in plan for “simple masonry buildings”.	Unchanged	

Clause	Subject	National choice[1)]	Complementary information
9.7.2(5)	Maximum difference in mass and wall area between adjacent storeys of "simple masonry buildings".	Unchanged	
10.3(2)P	Magnification factor on seismic displacements for isolation devices.	Unchanged	
Annex A Informative	Elastic displacement response spectrum.	Applicable.	
Annex B Informative	Determination of the target displacement for non-linear static (pushover) analysis.	Applicable.	
Anneks D DK NA	Annex D, DK NA – Danish alternative to the application of EN 1998-1	Applicable.	Non-contradictory, complementary information.

1)
Unchanged: The recommendation in the Eurocode to be followed.
No choice made: The Eurocode does not recommend values or methods, but allows the option of determining national values or methods. *Not applicable:* The Annex is not applicable.
Applicable: The Annex is applicable in Denmark and has the same status as specified in the Eurocode.
National choice: A national choice has been made.
Not relevant for building structures: See e.g. the National Annexes published by the National Road Directorate and Banedanmark.
No further information: The Eurocode allows for further information – no additional information is given.

National choices

3.1.2(1) Identification of ground types

Table 3.1 DK NA - Ground types

Ground type	**Description of stratigraphic profile**	**Parameters**		
		$v_{s,30}$ (m/s)	N_{SPT} (blows/30cm)	c_u (kPa)
A	Rock or other rock-like geological formation, including at most 5 m of weaker material at the surface.	> 800	-	-
B	Deposits of very dense sand, gravel, or very stiff clay, at least several tens of metres in thickness, characterised by a gradual increase of mechanical properties with depth.	360-800	> 50	> 250
C	Deep deposits of dense or medium-dense sand, gravel or stiff clay with thickness from several tens to many hundreds of metres.	180-360	15-50	70-250
D	Deposits of loose-to-medium cohesionless soil (with or without some soft cohesive layers), or of predominantly soft-to-firm cohesive soil.	<180	**4-**15	**40-**70
E	A soil profile consisting of a surface alluvium layer with v_s values of type C or D and thickness varying between about 5 m and 20 m, underlain by stiffer material with v_s>800 m / s.			
S_1	Deposits consisting, or containing a layer at least 10 m thick, of soft clays/silts with a high plasticity index (PI > 40) and high water content.	<100 (indicative)	-	10-20
S_2	Deposits of liquefiable soils, of sensitive clays, or any other soil profile not included in types A – E or S_1.			

NOTE: However, as in Table 3.1 of EN 1998-1 excepted for class D – modification is in **bold.**

Non-contradictory complementary information.

Annex D, DK NA – Danish alternative to the application of EN 1998-1

D.1 This annex gives simplified rules to be used for calculating the horizontal seismic action as an alternative to the application of EN 1998-1. Vertical seismic actions may be ignored.

D.2 Seismic actions include actions taken into account in order to safeguard the structure's strength and stability with regard to ground motions. The seismic action is the minimum horizontal action assumed to affect a structure, and shall not be taken as less than 1,5 % of the vertical load when applying Annex D. If the instructions in EN 1998-1 are followed, the seismic action may in some cases be reduced to a value less than 1,5 % of the vertical load.

D.3 The horizontal seismic action is assumed only to occur simultaneously with the associated vertical load. The design value of the horizontal seismic action per storey, F_{seis}, is determined on the basis of the vertical load as follows:

$$F_{seis} = \left(\sum G_{kj} + \sum_{i \geq 1} \Psi_{2,i} Q_{k,i} \right) \frac{a_{seis}}{g} \qquad \text{(D-1 DK NA)}$$

where

a_{seis} is the acceleration of seismic shear determined by (D-2 DK NA) [m/s^2]
g is the acceleration of gravity [m/s^2];

NOTE: The symbols are as given in Table A.1.3 DK NA in DS/EN 1990 DK NA:2019.

D.4 The horizontal seismic action is applied at storey level where the floors of the building are assumed to be rigid in plan.

D.5 The horizontal acceleration of seismic shear is determined by the following expression:

$$a_{seis} = \max \begin{cases} \frac{1}{q} k \left[\frac{S_e}{a_g} \right] a_g \, \gamma_I \\ 1{,}5\% \text{ af g} \end{cases} \qquad \text{(D-2 DK NA)}$$

where

q is taken as 1,5 taking into account the structural ductility. Alternative values of q can be found in EN 1998-1, under relevant material sections [-]

k is taken as 0,5 and takes into account that the effect of the horizontal seismic action is not constant along the building height [-]

S_e/a_g is given by Figure D.1 DK NA as a function of the natural period of vibration of the building [-]

a_g is the design ground acceleration and is found from Figure D.2 DK NA [m/s^2]

γ_I is the seismic factor related to the seismic class of the structure. The factor is taken as being equal to 0,8 for CC1; 1,0 for CC2 and 1,2 for CC3.

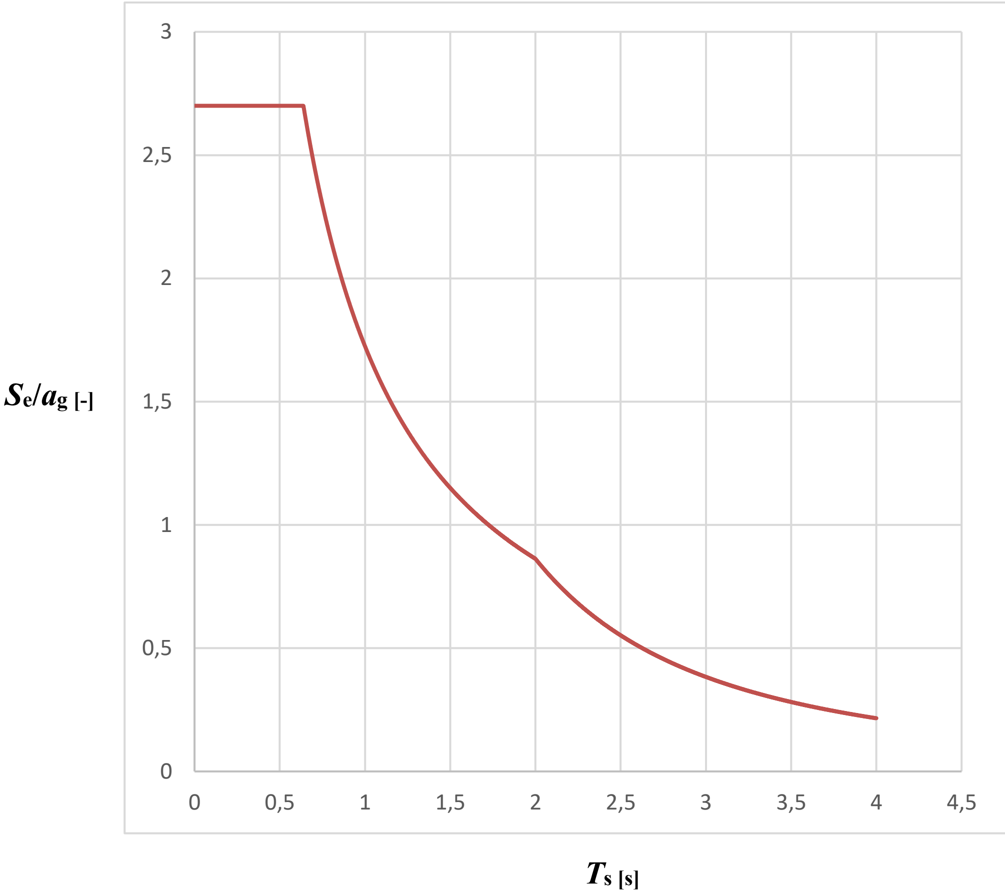

Figure D.1 DK NA: Normalized horizontal response spectrum S_e/a_g, as a function of the natural period of vibration of the building, T_s.

NOTE 1: For seismic class II buildings (where γ_I is equal to 1,0) with q=1,5, it is on the safe side to set a_{seis} to 1,5% of g when ag ≦ 0,16 m/s^2.

NOTE 2: The figure corresponds to Figure 3.2, curve C, of EN 1998-1. For small natural periods of vibration, S_e/a_g is assumed to be constant at 2,7 according to Figure D.1.

D.6 For multi-storey buildings, the period T_s of weak-axis bending vibrations may be estimated using the expression $T_s = h/60$ [s] for concrete and composite steel-concrete buildings, and the expression $T_s = h/46$ [s] for steel buildings, where h is the building height in [m].

NOTE: For buildings where the stiffness is established by a rectangular cross-section, the period T_s of strong-axis bending vibrations may be roughly estimated by multiplying the period of weak-axis bending vibrations with the ratio of the short and long side of the rectangle.

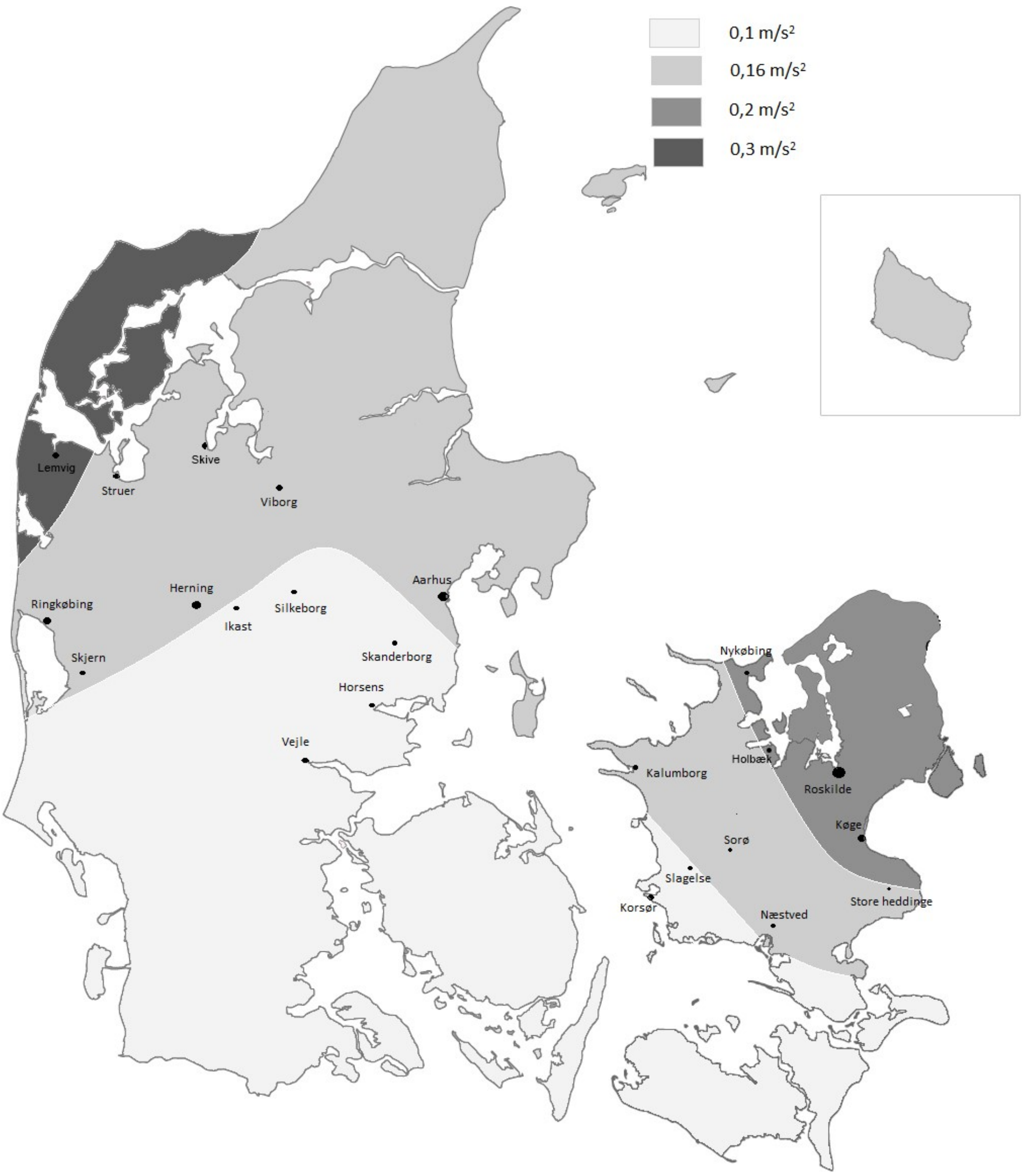

Figure D.2 DK NA: Values of design ground acceleration, a_g
The values are given in m/s2.