



DS/EN 1993-5 DK NA:2015 National Annex to Eurocode 3: Design of Steel Structures – Part 5: Piling

Preface

The implementation of Eurocodes has involved the preparation of:

- National Annexes to the bridge-specific Eurocodes
- Addenda to National Annexes for bridge-specific sections in Eurocodes for loads.

Together with the basic Eurocodes, including the related national annexes, these constitute the codes of practices to be applied in the design of bridges in Denmark.

Scope

This National Annex sets out the conditions for implementation of EN 1993-5.

Contents

This National Annex contains the national choices that apply in Denmark.

The national choices may be in the form of current national values, a choice between several methods or addition of supplementary guidance.

In connection with the national choices, the national annexes may refer to Banedanmark's Railway Standards (e.g. BN1-59) or Danish Road Directorate's Road Standards.

Reference may also be made to the infrastructure manager (IF). IF is the authority which has ownership and/or holds maintenance responsibility for a road bridge or for a railway bridge. Examples of IFs include the Danish Road Directorate, local authorities, Banedanmark and regional railway providers.

In addition, the National Annex includes an overview of all the items where it has been possible to make a national choice.



Items for which a national choice has been made

Page	Item	Subject	National choice
26	3.7 (1)	Minimum yield stress f _{y,spec} for anchors made of high strength steel	For anchors made of high strength steel $f_{y,spec} \ge f_{y,spec,max} = 500$ MPa Use of prestressing steel as anchors in the form of bars, the strength of which has been increased by post-processing in connection with the production, or cables made of cold-drawn threads and lines is on- ly possible if they meet the following ductility requirements, see prEN 10138-1 to -4, DS/EN 1992-1-1 including DK NA and DS/INF 165: $(f_{p,k}/f_{p0,1k}) \ge 1.1$, $\varepsilon_{uk} \ge 3.5\%$ Reinforcing steel and other steel bars with threads shall as a minimum meet the requirements corresponding to class B in Annex C in DS/EN 1992-1-1 including DK NA. Note: Yield stress and tensile strength of typical anchor steels are set out in Annex I of DS 1537.
27	3.9 (1)P	Lowest service temperature to be used for assessing fracture toughness	A temperature of -30°C is used.
30	4.4 (1)	Corrosion rates to be considered in connection with the design	The recommended values can be used. It shall always be assessed whether local conditions can lead to great- er values than those recommended in the tables, e.g. the presence of flowing groundwater, location close to roads and paths that are salted during the winter months, etc. Or whether, subject to 4.1, it shall be assessed how corrosion can be limited. Welding of interlocking may also be relevant where there is risk for water reaching the interlock- ing. Corrosion loss corresponding to a lifespan of 120 years can be deter- mined by linear extrapolation. Corrosion rates in fresh water and sea water may differ significantly from the rates stated, which is why the use of a corrosion protection system may be required.
32	5.1.1 (4)	Partial coefficients on the ma- terial side	The following values are used: $\gamma_{M0} = 1.10 \gamma_3 \gamma_0$ $\gamma_{M1} = 1.20 \gamma_3 \gamma_0$ $\gamma_{M2} = 1.35 \gamma_3 \gamma_0$ For prestressing steel in the form of bars post-processed in connection with production, or cables made of cold-drawn threads and lines, a partial coefficient for f _{p0.1k} shall be used as for reinforcement, SE DS/EN 1992-1-1 including DK NA: $\gamma_S = 1.20 \gamma_3 \gamma_0$ The partial coefficient $\gamma_S = 1.20 \gamma_3 \gamma_0$ shall also be used for f _{yk} (f _{0.2 k}) for reinforcing steel and other steel bars with threads. In respect of γ_3 and γ_0 reference is made to DS/EN 1993-1-1 DK NA, DS/EN 1992-1-1 DK NA and DS/EN 1990 DK NA. Note: Use of strict control requires independent 3rd party tests of materials and the execution, see DS/EN 1990 DK NA.

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Page	Item	Subject	National choice
35	5.2.2 (2)	Factor β_B for single and double U profiles, which takes into account the possible lack of shear capacity in interlocks	See Table DK NA.1 below with accompanying notes. Note: Table NA.2 from NA to BS EN1993-5:2007 is adopted and adapted.
53	6.4 (3)	Factor β_D to determine the effective bending stiffness of U profiles	See Table DK NA.1 below with accompanying notes. Note: Table NA.2 from NA to BS EN1993-5:2007 is adopted and adapted.
54	7.1 (4)	Partial coefficients on the ma- terial side for joints	The following values are used: $\gamma_{M2} = 1.35 \gamma_3 \gamma_0$ $\gamma_{M3,ser} = 1.20 \gamma_3 \gamma_0$
55	7.2.3 (2)	Factor k _t of tensile resistance of anchor with threads	The following factors can be used if the detailing ensures that there is no bending in the anchor: Rolled on threads: $k_t = 1.0$ Rolled threads: $k_t = 0.9$ Cut threads: $k_t = 0.75$ If this is not the case, the above values shall be reduced by factor 2/3. If an anchor is made with a thread on a section that is longer than 1m, safety against accidental yielding shall be ensured by replacing A_g with A_s in formula (7.2).
56	7.4.2 (4), NOTE	Joints between two pile ele- ments	Joints between pile elements should be designed for the forces which occur in both the permanent situation and during pile driving. The necessary contact shall be ensured between the pile elements.
93	D.2.2 (5), NOTE	Requirements for sand density and clay stiffness for filled round pipes	Verification of protection against folding may be omitted locally where the pipe is filled with concrete or sand. In all other cases, the verification shall take into account the strength and stiffness of the material in the pipe.



Table DK NA.1

Type of U profile	Number of struc- tural support levels (see note 1)	Reduction factors β_B and β_D referred to in 5.2.2 (2), 5.2.2 (9), 5.2.3 (2) and 6.4 (3) (see notes 2, 3, 4 and 5)					
e prome		Very unfavourable con- ditions (see note 6)		Unfavourable conditions (see note 7)		Favourable conditions (see note 8)	
		β_B	β_D	β_B	β_D	β_B	β_D
Single or double	0	0.40	0.30	0.50	0.35	0.60	0.40
pile without	1	0.55	0.35	0.60	0.40	0.70	0.45
pinching	>1	0.65	0.45	0.70	0.50	0.80	0.55
Pinched	0	0.70	0.60	0.75	0.65	0.80	0.70
or welded dou-	1	0.80	0.70	0.85	0.75	0.95	0.80
ble pile	>1	0.90	0.80	0.95	0.85	1.00	0.90

NOTE 1 Any support that causes the shear force to change sign can be considered as a structural support. The tip (foot) of sheet pile walls should not be regarded as a support. The design effect of a support can only be included after the establishment of the support. Supports can only be regarded as structural when they are designed as such in accordance with relevant design standards.

NOTE 2 If interlocking is treated with sealant or lubricant, the reduction factors may increase by 0.05 (however, not to more than 1.0).

NOTE 3 The interlocking on single piles or double piles without pinching should be welded using fillet welds, min. a measure 6 mm at the top after installation. The weld length should be at least 100 mm for free wall heights up to 2.5 m. For greater free wall heights, the weld length should be increased by 100 mm for each additional metre of free wall height until a weld length of 500 mm is reached (for free wall heights above 6.5 m). If such welds can be established, the β_B and β_B factors can be increased, see the table below (but no to more than 1.0).

Conditions	An increase in β factors by welding in accordance with the above Note 3.		
	$\beta_{\!B}$	β_D	
Very unfavourable conditions (see note 6)	0.10	0.15	
unfavourable conditions (see note 7)	0.15	0.20	
Favourable conditions (see note 8)	0.20	0.25	

NOTE 4 An increase in the β factors shall be taken into account if calculation, testing or otherwise can document that a higher degree of shear transmission can be mobilised than prescribed by the above table DK NA.1 with accompanying notes.

Note 5 the β factors should be selected corresponding to the least favourable conditions above the wall height.

NOTE 6 Very unfavourable conditions are:

- Casings with significant free water pressure;
- Significant occurrence of fine-grained soil with very low strength or very loose, settled coarse-grained soil (as defined in DS/EN ISO 14688-1 and -2);
- Artificial weakening by predrilling in fine-grained soil below final excavation level (unless it can be documented by testing or in any other way that the pre-drilled soil results in equivalent or better friction than fine-grained soil with low strength or loose, settled coarse-grained soil so that more favourable conditions can be assumed);
- Artificial weakening of fine-grained soil by water jetting at more than 240 litres per minute (see Annex D.2 in DS/EN 12063:1999) or
- Artificial weakening of coarse-grained soil by water jetting at more than 480 litres per minute (see Annex D.2 in DS/EN 12063:1999)

NOTE 7 Unfavourable conditions are:

- Significant occurrence of fine-grained soil with low strength or loose, settled coarse-grained soil (as defined in DS/EN ISO 14688-1 and -2);
- Artificial weakening by predrilling in coarse-grained soil below final excavation level (unless it can be documented by testing or in any other way that the pre-drilled soil results in equivalent or better friction than medium-firmly settled coarse-grained soil so that more favourable conditions can be assumed);
- Artificial weakening of fine-grained soil by water jetting at between 60 and 240 litres per minute (see annex D.2 in DS/EN 12063:1999) or, in case of artificial weakening of coarse-grained soil at between 240 and 480 litres per minute.

NOTE 8 Favourable conditions can be assumed if none of the very unfavourable or unfavourable conditions exist.



Overview of possible national choices

The following overview shows the places where a national choice is possible and which informative annexes that apply/do not apply. Moreover, it is specified where a national choice has been made.

In addition, this National Annex provides references to supplementary (non-conflicting) information which may assist to the user of the Eurocode.

Page	Item	Subject	National choice
26	3.7 (1)	Minimum yield stress f _{y,spec} for anchors made of high strength steel	No national choice. However, supplementary text is provided.
27	3.9 (1)P	Lowest service temperature to be used for assessing fracture toughness.	National choice specified.
30	4.4 (1)	Corrosion rates to be consid- ered in connection with the design.	No national choice. However, supplementary text is provided.
32	5.1.1 (4)	Partial coefficients on the ma- terial side.	National choice specified.
35	5.2.2 (2)	Factor β_B for single and double U profiles, which takes into account the possible lack of shear capacity in interlocks.	National choice specified.
37	5.2.2 (13)	Minimum length <i>l</i> of butt welds at each end of the inter- locking.	No national choice.
43	5.2.5 (7)	Reduction factor β_R for tension resistance of interlocking joints for flat steel sheet piling.	No national choice.
51	5.5.4 (2)	Reduction of overall capacity of main elements due to forces introduced by secondary ele- ments via connecting devices for combined sheet-pile walls, e.g. in case of considerable differential water pressure.	No national choice.
53	6.4 (3)	Factor β_D to determine the effective bending stiffness of U profiles.	National choice specified.
54	7.1 (4)	Partial coefficients on the ma- terial side for joints.	National choice specified.
55	7.2.3 (2)	Factor k_t of tensile resistance of anchor with threads.	National choice specified.
56	7.4.2 (4), NOTE	Joints between two pile ele- ments.	National choice specified.
	Annex A (norma- tive)	Thin walled steel sheet piling.	
67	A.3.1 (3)	Minimum ductility require- ments.	No national choice.
	Annex B (informative)	Testing of thin walled steel sheet piling.	This annex applies as an informative annex.
83	B.5.4 (1)	Factor η_{sys} that takes into account possible differences in behaviour between the service and testing situation.	No national choice.
	Annex C (informative)	Guidelines for the design of sheet-pile walls.	This annex applies as an informative annex.

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Page	Item	Subject	National choice
	Annex D	Main elements for combined	This annex applies as an informative annex.
	(informative)	walls.	
93	D.2.2 (5), NOTE	Requirements for sand density	National choice specified.
		and clay stiffness for filled	
		round pipes.	

Note: No national choice implies that a recommendation in the code of practice is observed.

DISCLAIMER

The translation into English of Road Standards (Vejregler), Tender Specifications and National Annexes is to be regarded entirely as a service. In the event of any discrepancy or short-comings in the translation, the Danish version will prevail. At any time the Danish versions of Road Standards (Vejregler), Tender Specifications and National Annexes are those in force.