DS/EN 1992-2 DK NA:2015

National Annex to

Eurocode 2: Concrete structures – Part 2: Concrete bridges – Design and detailing rules

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 1992-2.

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.

banedanmark

Vejdirektoratet

Items for which a national choice has been made

<table>
<tr><th>Page</th><th>Item</th><th>Subject</th><th>National choice</th></tr>
<tr><td>13</td><td>3.1.2 (102)P</td><td>Concrete strength classes.</td><td>If f_{ck} > 50 MPa, this shall be approved by the infrastructure manager, and all execution conditions shall be determined for the specific project.</td></tr>
<tr><td>14</td><td>3.1.6 (101)P</td><td>Design compressive strength.</td><td>α_{cc} = 1.0.</td></tr>
<tr><td>14</td><td>3.1.6 (102)P</td><td>Design tensile strength.</td><td>α_{ct} = 1.0</td></tr>
<tr><td>15</td><td>4.2 (105)</td><td>Exposure class for waterproofed bridge decks.</td><td>Waterproofed bridge decks can be related to the aggressive environmental class. For bridge decks with thin pavements with synthetic binder, however, extra aggressive environmental class.

For the relationship between exposure classes and environmental classes, reference is made to EN 1992-1-1 with the related national annex including addendum.</td></tr>
<tr><td>15</td><td>4.2 (106)</td><td>Distance from carriageway or path where exposed surfaces are de-iced.</td><td>Distances are selected as:

For road and foot bridges:
x = 3 m
y = 3 m

For railway bridges:
x = 5 m
y = 3 m</td></tr>
<tr><td>15</td><td>4.2 (106)</td><td>Exposure classes for surfaces directly affected by de-icing salts.</td><td>Surfaces directly affected by de-icing salts can be related to the extra aggressive environmental class. In addition, edge beams for railway bridges are related to the extra aggressive environmental class.

For the relationship between exposure classes and environmental classes, reference is made to EN 1992-1-1 with the related national annex including addendum.</td></tr>
<tr><td>15</td><td>4.4.1.2(5) in EN 1992-1-1:2005 and DK NA</td><td>Minimum cover regarding the durability on non-prestressed and prestressed reinforcement</td><td>The requirements stated in DS/EN 1992-1-1 DK NA are amended to:

Table 4.4 DK NA Values of minimum cover, $c_{min,dur}$, requirements with regard to durability of non-prestressed reinforcing steel in conformity with DS/EN 10080
<table>
<tr><th>Environmental class</th><th>Minimum cover [mm]</th></tr>
<tr><td>Extra aggressive</td><td>50</td></tr>
<tr><td>Aggressive</td><td>40</td></tr>
</table>
Table 4.5 DK NA Values of minimum cover, $c_{min,\ dur}$, requirements with regard to the durability of prestressed steel*)
<table>
<tr><th rowspan="2">Environmental class</th><th colspan="2">Minimum cover [mm]</th></tr>
<tr><th><u>Pre-stressed reinforcement - not bundled</u></th><th><u>Post-stressed reinforcement in casing</u></th></tr>
<tr><td>Extra aggressive</td><td>50</td><td>60</td></tr>
<tr><td>Aggressive</td><td>40</td><td>50</td></tr>
</table>
*) For prestressed railway bridges across roads where there is a risk of collision and where the depth point of the tensioned reinforcement is placed above lanes, a cover of at least 75 mm for the tensioned reinforcement closest to the bridge underside shall be used.

Passive and moderate environmental class are not used for bridges.</td></tr>
<tr><td>15</td><td>4.4.1.2 (109)</td><td>Minimum cover at casting against existing concrete</td><td>Covers shall observe the same requirements as for new concrete structures.</td></tr>
<tr><td>15</td><td>4.4.1.3(1)P i EN 1992-1-1 and DK NA</td><td>Supplement for the design of tolerances</td><td>The tolerance supplement Δc_{dev} is set at 5 mm in normal and strict control class (modified control class should not be used for bridges).

Prescribed minimum cover in respect of durability of non-prestressed and</td></tr>
</table>

Page	Item	Subject	National choice
			prestressed reinforcement is thus determined as: $c_{min,dur}$ + 5 mm.
18	5.2 (105)	Geometrical imperfections in compression members of units of pressure and structures exposed to vertical loads.	The National Annex for Buildings structures DS/EN 1991-1-1 DK NA does not apply, and horizontal mass load is thus not used. The recommended value of θ_0 = 1/200 shall be used.
19	5.5 (104)	Linear elastic analysis with limited redistribution.	The recommended value k_5 = 0.85 shall be used.
20	5.7 (105)	Non-linear analyses.	Where no non-linear analyses are made, the method and safety format should be agreed on a case-by-case basis.
23	6.1 (109) (Method b)	Verification of resistance to brittle fractures in method b).	Not applicable since method a) shall be used.
23	6.1 (109)	Verification of resistance to brittle fractures.	Method a) to be used.
23	6.1 (110)	Verification of resistance to brittle fractures.	Not applicable since method a) shall be used.
	6.2.3(2) EN 1992-1-1and DK NA	Shear reinforced cross sections.	However, longitudinal reinforcement anchoring may limit the increase in cot θ.
26	6.2.3 (103)	Shear reinforced cross sections.	The recommended expressions for α_{cw} to be used. The recommended value for ν_1 to be used, i.e. $\nu_1 = \nu$. For the calculation of ν, reference is made to additional information in 5.6.1(3)P in DS/EN 1992-1-1 DK NA (Additional non-conflicting information).
26	6.2.3 (107)	Guidance regarding superposition of various grid models.	The guidance provided shall be disregarded. The contribution of the prestress to the shear load capacity can be calculated as the force component of the pre-stressed reinforcement perpendicular on the longitudinal axis. This contribution cannot have a higher value than the value corresponding to use of the design yield stress of the prestressed reinforcement or the 0.2 % stress.
28	6.2.3 (109)	'Segmental construction' with 'unbonded' prestress, calculation of shear capacity when joints are opened.	The recommended minimum value h_{red} = 0.5 h is used.
29	6.2.5 (105)	Construction joint between concrete, fatigue	For fatigued construction joints between concrete, c in 6.2.5 (1) should be taken as zero for all verifications other than fatigue.
33	6.8.1 (102)	Conditions for fatigue verification.	The following is added in NOTE: h) Bridge decks for road bridges with considerable transverse load distribution, such as in in-situ cast monolithic bridge decks with slab-shaped cross-section.

<table>
<tr><th>Page</th><th>Item</th><th>Subject</th><th>National choice</th></tr>
<tr><td>36</td><td>7.3.1 (105)</td><td>Requirements for maximum crack widths.</td><td>Recommended maximum values of calculated crack widths w_{max} depending on the environmental class are stated as follows:</td></tr>
<tr><td colspan="4">
Table 7.101N DK NA
<table>
<tr><th>Road bridges and footbridges</th><th colspan="2">Non-prestressed structures</th><th colspan="2">Pre- and post-stressed structures</th></tr>
<tr><th>Load combination</th><th>Quasi-permanent</th><th>Frequent</th><th>Quasi-permanent</th><th>Frequent</th></tr>
<tr><td>Environmental class</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Moderate</td><td>N/A</td><td>N/A</td><td rowspan="3">Section perpendicular on the prestress shall be tensile stress free in all areas of the section</td><td>N/A</td></tr>
<tr><td>Aggressive</td><td>-</td><td>0.30 mm</td><td>0.20 mm</td></tr>
<tr><td>Extra Aggressive</td><td>-</td><td>0.20 mm</td><td>0.10 mm</td></tr>
</table>
Note:

For prestressed structures the following requirements also apply:

1) In the transverse direction, if it is not prestressed, the crack width requirement applies to non-reinforce structures. In areas where the longitudinal prestressed reinforcement is located at a distance of less than 400 mm from the concrete surface, the same crack width requirements apply in the transverse direction as in the prestressed direction.

2) In interim situations where the prestressed structure is only affected by self-weight and initial prestress the crack width requirement may be relaxed to w_{max} = 0.30 mm, if the crack formation will not impact on durability. Initial prestress means prestressing forces, including loss of interlocking, but excluding effects from creep and shrinkage and relaxation.

<table>
<tr><th>Railway bridges</th><th colspan="2">Non-prestressed structures</th><th colspan="2">Pre- and post-stressed structures</th></tr>
<tr><th>Load combination</th><th>Quasi-permanent</th><th>Frequent</th><th>Quasi-permanent</th><th>Frequent</th></tr>
<tr><td>Environmental class</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Moderate</td><td>N/A</td><td>N/A</td><td rowspan="3">Section at right angles on the pre-stress shall be drafts unit voltage-free in all points of the section</td><td>N/A</td></tr>
<tr><td>Aggressive</td><td>-</td><td>0.30 mm</td><td>0.10 mm</td></tr>
<tr><td>Extra Aggressive</td><td>-</td><td>0.20 mm</td><td>0.10 mm</td></tr>
</table>
Note:

For prestressed structures the following requirements also apply:

1) In the transverse direction, if it is not prestressed, the crack width requirement applies to non-reinforce structures. In areas where the longitudinal prestressed reinforcement is located at a distance of less than 400 mm from the concrete surface, the same crack width requirements apply in the transverse direction as in the prestressed direction.

2) In interim situations where the prestressed structure is only affected by self-weight and initial prestress, efforts should be made to make the structure crack-free, since the maximum permissible tensile stress is set to be equal to the characteristic tensile strength of the concrete. However, in exceptional cases, local crack formation with crack widths up to w_{max} = 0.20 mm may be accepted if the crack formation will not impact durability. Initial prestress means prestressing forces, including loss of interlocking, but excluding effects from creep and shrinkage and relaxation.
</td></tr>
<tr><td>39</td><td>7.3.3 (101)</td><td>Method for control of cracking without direct calculation.</td><td>The recommended method may not be used.</td></tr>
<tr><td>42</td><td>8.10.4 (107)</td><td>Cable anchoring that in exceptional cases is placed on the upper side of the bridge deck.</td><td>A waterproofing film should be laid above openings and pockets.

Moreover, stainless reinforcement/stainless struts shall be used in construction</td></tr>
</table>

<table>
<tr><th>Page</th><th>Item</th><th>Subject</th><th>National choice</th></tr>
<tr><td></td><td></td><td></td><td>joints against openings and pockets.

Cable anchoring on the upper side of bridge decks shall under no circumstances be placed in gutters and depth points.</td></tr>
<tr><td>46</td><td>11.9 (101)</td><td>Restrictions on the use of bundled reinforcement in LWAC.</td><td>Reinforcing bars in bundles shall always be cast individually.</td></tr>
<tr><td>47</td><td>113.2 (102)</td><td>Unbalanced wind pressure on one of the cantilevers of a cantilevered structure.</td><td>To be determined for the specific project.</td></tr>
<tr><td>49</td><td>Annex A (Informative)</td><td>Modifications of partial factors for materials.</td><td>Annex A is not applicable.
(see DS/EN 1992-1-1 DK NA)</td></tr>
<tr><td>49</td><td>Annex B (Informative)</td><td>Creep and shrinkage strain.</td><td>Annex B applies as an informative annex.</td></tr>
<tr><td rowspan="2">55</td><td>Annex E (informative)</td><td>Indicative strength classes for durability.</td><td>Annex E applies as an informative annex, since table E.1N is replaced by the following table:</td></tr>
<tr><td></td><td colspan="2"><table>
<tr><th colspan="2">Table E.1N DK NA</th></tr>
<tr><th>Environmental class[1)]</th><th>Minimum of prescribed f_{ck} (MPa)</th></tr>
<tr><td>Passive</td><td>Not used</td></tr>
<tr><td>Moderate</td><td>Not used</td></tr>
<tr><td>Aggressive</td><td>35</td></tr>
<tr><td>Extra Aggressive</td><td>40</td></tr>
<tr><td colspan="2">Note:
[1)] For the relationship between exposure classes and environmental classes, reference is made to EN 1992-1-1 with the related national annex including addenda.</td></tr>
</table></td></tr>
<tr><td>56</td><td>Annex F (informative)</td><td>Tension reinforcement expressions for in-plane stress conditions.</td><td>Annex F is not applicable, but is replaced by Annex F in DS/EN 1992-1-1 (see also additional non-conflicting information in DS/EN 1992-1-1 DK NA regarding the determination of the efficiency factor).</td></tr>
<tr><td>58</td><td>Annex G (informative)</td><td>Soil structure interaction.</td><td>Annex G is not applicable.</td></tr>
<tr><td>58</td><td>Annex H (informative)</td><td>Global second order effects in structures.</td><td>Annex H is not applicable.</td></tr>
<tr><td>59</td><td>Annex I (informative)</td><td>Analysis of flat slabs and shear walls.</td><td>Annex I is not applicable.</td></tr>
<tr><td>60</td><td>Annex J (informative)</td><td>Detailing rules for particular situations.</td><td>Annex J is applicable.</td></tr>
<tr><td>63</td><td>Annex KK (informative)</td><td>Structural effects of time dependent behaviour of concrete.</td><td>Annex KK is applicable.</td></tr>
<tr><td>68</td><td>Annex LL (informative)</td><td>Concrete shell elements.</td><td>Annex LL is not applicable.</td></tr>
<tr><td>75</td><td>Annex MM (informative)</td><td>Shear and transverse bending.</td><td>Annex MM is not applicable.</td></tr>
<tr><td>77</td><td>Annex NN (informative)</td><td>Damage equivalent stresses for fatigue verification.</td><td>Annex NN is applicable.</td></tr>
<tr><td>86</td><td>Annex OO (informative)</td><td>Typical bridge discontinuity regions.</td><td>Annex OO is applicable.</td></tr>
<tr><td>92</td><td>Annex PP (informative)</td><td>Safety format for non linear analysis.</td><td>Annex PP is not applicable.</td></tr>
<tr><td>95</td><td>Annex QQ (informative)</td><td>Control of shear cracks within webs.</td><td>Annex QQ is not applicable.</td></tr>
</table>

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
13	3.1.2 (102)P	Concrete strength classes.	National choice specified.
14	3.1.6 (101)P	Design compressive strength.	National choice specified.
14	3.1.6 (102)P	Design tensile strength.	National choice specified.
14	3.2.4 (101)P	Reinforcement class.	No national choice.
15	4.2 (105)	Exposure class for waterproofed bridge decks.	National choice specified.
15	4.2 (106)	Distance from carriageway or path where exposed surfaces are de-iced.	National choice specified.
15	4.2 (106)	Exposure classes for surfaces directly affected by de-icing salts.	National choice specified.
15	4.4.1.2 (109)	Cover on bridges and structures.	National choice specified.
18	5.1.3 (101)P	Load cases and combinations.	No national choice.
18	5.2 (105)	Geometrical imperfections in compression members of units of pressure and structures exposed to vertical loads.	National choice specified.
19	5.3.2.2 (104)	Reduction of rotation over support.	No national choice.
19	5.5 (104)	Linear elastic analysis with limited redistribution.	National choice specified.
20	5.7 (105)	Non-linear analyses.	National choice specified.
23	6.1 (109) (Method b)	Verification of resistance to brittle fractures in method b).	National choice specified.
23	6.1 (109)	Verification of resistance to brittle fractures.	National choice specified.
23	6.1 (110)	Verification of resistance to brittle fractures.	National choice specified.
	6.2.3(2) EN 1992-1-1 and DK NA	Shear reinforced cross sections.	National choice specified.
25	6.2.2(101)	Non-shear reinforced cross sections.	No national choice.
26	6.2.3 (103)	Shear reinforced cross sections.	National choice specified.
26	6.2.3 (107)	Guidance regarding superposition of various grid models.	National choice specified.
28	6.2.3 (109)	'Segmental construction' with 'unbonded' prestress, calculation of shear capacity when joints are opened.	National choice specified.
29	6.2.5 (105)	Construction joint between concrete, fatigue	Clarification stated.
33	6.8.1 (102)	Conditions for fatigue	National choice specified.

Page	Item	Subject	National choice
		verification.	
33	6.8.7 (101)	Verification of the fatigue strength of concrete under compression or shear.	No national choice.
34	6.8.7 (101)	Design fatigue strength of concrete.	No national choice.
36	7.2 (102)	Stress limits.	No national choice.
36	7.3.1 (105)	Requirements for maximum crack widths.	National choice specified.
37	7.3.1 (105)	Distance between fibres in decompression and casing for cables.	No national choice.
39	7.3.3 (101)	Method for control of cracking without direct calculation.	No national choice.
39	7.3.4 (101)	Method for calculating crack widths.	No national choice.
41	8.9.1 (101)	Bundling of reinforcing bars of different diameters.	No national choice.
41	8.10.4 (105)	Extent of couplers in one section.	No national choice.
41	8.10.4 (105)	Minimum distance between cross sections in which cables are coupled.	No national choice.
42	8.10.4 (107)	Cable anchoring that in exceptional cases is placed on the upper side of the bridge deck.	National choice specified.
43	9.1 (103)	Minimum area of reinforcement.	No national choice.
43	9.2.2 (101)	Design of shear reinforcement.	No national choice.
44	9.5.3 (101)	Minimum diameter for transverse reinforcement in columns.	No national choice.
44	9.7 (102)	Maximum reinforcement distance between mesh reinforcement for deep beams.	No national choice.
44	9.8.1 (103)	Minimum diameter of reinforcing bars in piled foundations.	No national choice.
46	11.9 (101)	Restrictions on the use of bundled reinforcement in LWAC.	National choice specified.
47	113.2 (102)	Unbalanced wind pressure on one of the cantilevers of a cantilevered structure.	National choice specified.
48	113.3.2 (103)	Requirements for tensile stresses for quasi-permanent load combinations during execution.	No national choice.
49	Annex A (Informative)	Modifications of partial factors for materials.	Annex A is not applicable.
49	Annex B (Informative)	Creep and shrinkage strain.	Annex B applies as an informative annex.
55	Annex D (informative)	Detailed calculation method for prestressing steel relaxation losses.	Annex D applies as an informative annex.
55	Annex E (informative)	Indicative strength classes for durability.	National choice specified.
56	Annex F (informative)	Tension reinforcement expressions for in-plane stress conditions.	Annex F is not applicable, but is replaced by annex F in EN 1992-1-1 (see also additional non-conflicting information in EN 1992-1-1 DK NA regarding the determination of the efficiency factor).
58	Annex G (informative)	Soil structure interaction.	Annex G is not applicable.
58	Annex H (informative)	Global second order effects in structures.	Annex H is not applicable.
59	Annex I (informative)	Analysis of flat slabs and shear walls.	Annex I is not applicable.
60	Annex J (informative)	Detailing rules for particular situations.	Annex J is applicable.

Page	Item	Subject	National choice
63	Annex KK (informative)	Structural effects of time dependent behaviour of concrete.	Annex KK is applicable.
68	Annex LL (informative)	Concrete shell elements.	Annex LL is not applicable.
75	Annex MM (informative)	Shear and transverse bending.	Annex MM is not applicable.
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86	Annex OO (informative)	Typical bridge discontinuity regions.	Annex OO is applicable.
92	Annex PP (informative)	Safety format for non linear analysis.	Annex PP is not applicable.
95	Annex QQ (informative)	Control of shear cracks within webs	Annex QQ is not applicable.

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