DS/EN 1993-1-1 DK NA:2015

National Annex to
Eurocode 3: Design of steel structures –
Part 1-1: General rules and rules for buildings

Foreword

This national annex (NA) is a revision of DS/EN 1993-1-1 DK NA:2014 and replaces the latter on 2015-01-01. In addition to minor editorial changes, the publication of DS/EN 1993-1-1/A1:2014 has resulted in the addition of national choices in C.2.2(3) and C.2.2(4); the complementary information regarding 2.1.2 has consequently been deleted.

Previous versions of and addenda to this NA as well as an overview of all NAs can be found at www.eurocodes.dk

This NA lays down the conditions for the implementation in Denmark of EN 1993-1-1 for construction works in conformity with the Danish Building Act or the building legislation. Other parties can put this NA into effect by referring thereto.

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

This NA includes:

- an overview of possible national choices and clauses containing complementary information;
- national choices;
- complementary, non-contradictory information.
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.

<table>
<thead>
<tr>
<th>Clause</th>
<th>Subject</th>
<th>National choice</th>
<th>Complementary information</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.3.1(1)</td>
<td>Actions and environmental influences</td>
<td>Unchanged</td>
<td></td>
</tr>
<tr>
<td>3.1(2)</td>
<td>Materials, General</td>
<td>National choice</td>
<td></td>
</tr>
<tr>
<td>3.2.1(1)</td>
<td>Material properties</td>
<td>National choice</td>
<td></td>
</tr>
<tr>
<td>3.2.2(1)</td>
<td>Ductility requirements</td>
<td>Unchanged</td>
<td></td>
</tr>
<tr>
<td>3.2.3(1)</td>
<td>Fracture toughness&quot;</td>
<td>Unchanged</td>
<td></td>
</tr>
<tr>
<td>3.2.3(3)B</td>
<td>Fracture toughness&quot;</td>
<td>Unchanged</td>
<td></td>
</tr>
<tr>
<td>3.2.4(1)B</td>
<td>Through-thickness properties</td>
<td>Unchanged</td>
<td>Complementary information</td>
</tr>
<tr>
<td>5.2.1(3)</td>
<td>Effects of deformed geometry of the structure</td>
<td>National choice</td>
<td></td>
</tr>
<tr>
<td>5.2.2(8)</td>
<td>Structural stability of frames</td>
<td>Complementary information</td>
<td></td>
</tr>
<tr>
<td>5.3.2(3)</td>
<td>Imperfections for global analysis of frames</td>
<td>Unchanged</td>
<td></td>
</tr>
<tr>
<td>5.3.2(11)</td>
<td>Imperfections for global analysis of frames</td>
<td>National choice</td>
<td></td>
</tr>
<tr>
<td>5.3.4(3)</td>
<td>Member imperfections</td>
<td>Unchanged</td>
<td></td>
</tr>
<tr>
<td>6.1(1)</td>
<td>National choice</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.1(1)B</td>
<td>Ultimate limit states, General</td>
<td>National choice</td>
<td></td>
</tr>
<tr>
<td>6.2.2</td>
<td>Resistance of cross-sections - Section proper-ties</td>
<td></td>
<td>Complementary information</td>
</tr>
<tr>
<td>6.3.2.2(2)</td>
<td>Lateral torsional buckling curves – General case</td>
<td>Unchanged</td>
<td></td>
</tr>
<tr>
<td>6.3.2.3(1)</td>
<td>Lateral torsional buckling curves for rolled sections or equivalent welded sections</td>
<td>Unchanged</td>
<td></td>
</tr>
<tr>
<td>6.3.2.3(2)</td>
<td>Lateral torsional buckling curves for rolled sections or equivalent welded sections</td>
<td>National choice</td>
<td>Complementary information</td>
</tr>
<tr>
<td>6.3.2.4(1)B</td>
<td>Simplified assessment methods for beams with restraints in buildings</td>
<td>Unchanged</td>
<td></td>
</tr>
<tr>
<td>6.3.2.4(2)B</td>
<td>Simplified assessment methods for beams with restraints in buildings</td>
<td>Unchanged</td>
<td></td>
</tr>
<tr>
<td>6.3.3(5)</td>
<td>Interactive factors for members in bending and axial compression</td>
<td>National choice</td>
<td>Complementary information</td>
</tr>
<tr>
<td>Clause</td>
<td>Subject</td>
<td>National choice</td>
<td>Complementary information</td>
</tr>
<tr>
<td>--------------</td>
<td>-------------------------------------------------------------------------</td>
<td>-----------------</td>
<td>---------------------------</td>
</tr>
<tr>
<td>6.3.4(1)</td>
<td>General method for lateral and lateral torsional buckling of structural components</td>
<td>National choice</td>
<td></td>
</tr>
<tr>
<td>7.2.1(1)B</td>
<td>Vertical deflections</td>
<td>National choice</td>
<td></td>
</tr>
<tr>
<td>7.2.2(1)B</td>
<td>Horizontal deflections</td>
<td>National choice</td>
<td></td>
</tr>
<tr>
<td>7.2.3(1)B</td>
<td>Dynamic effects</td>
<td>Unchanged</td>
<td></td>
</tr>
<tr>
<td>Annex A</td>
<td></td>
<td>Applicable</td>
<td></td>
</tr>
<tr>
<td>Annex B</td>
<td></td>
<td>Applicable</td>
<td>Complementary information</td>
</tr>
<tr>
<td>Annex AB</td>
<td></td>
<td>Applicable</td>
<td></td>
</tr>
<tr>
<td>Annex BB</td>
<td></td>
<td>Applicable</td>
<td></td>
</tr>
<tr>
<td>BB.1.3(3)B</td>
<td>Hollow sections as members</td>
<td>National choice</td>
<td></td>
</tr>
<tr>
<td>C.2.2(3)</td>
<td>Selection of execution class - general</td>
<td>National choice</td>
<td></td>
</tr>
<tr>
<td>C.2.2(4)</td>
<td>Selection of execution class - components</td>
<td>National choice</td>
<td></td>
</tr>
</tbody>
</table>

1) *Unchanged:* The recommendation in the Eurocode is 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 the National Annexes published by the Danish Road Directorate and Banedanmark.
National choices

3.1(2) Materials, General
The standard applies to steel materials in accordance with Table 3.1 of DS/EN 1993-1-1 or equivalent.

3.2.1(1) Material properties
The values of $f_y$ and $f_u$ specified in (1) a) should be used.

5.2.1(3) Effects of deformed geometry of the structure
A lower value of $a_{cr}$ than that that given in (5.1) may be used if justification of its application is documented.

5.3.2(11) Imperfections for global analysis of frames
Which of the methods referred to in (3), (6) and (11) to be used should be determined for each individual case.

6.1(1) Ultimate limit states, General
The below expressions for $\gamma_{Mi}$ are used, including the factor ($\gamma_0$) on the partial factors for strength parameters and resistances, cf. National Annex to EN 1990, Table A1.2(B+C) DK NA:

\[
\begin{align*}
\gamma_{M0} &= 1,1 \cdot \gamma_0 \cdot \gamma_3 \\
\gamma_{M1} &= 1,2 \cdot \gamma_0 \cdot \gamma_3 \\
\gamma_{M2} &= 1,35 \cdot \gamma_0 \cdot \gamma_3
\end{align*}
\]

The factor $\gamma_0$ takes into account the combination of actions, cf. National Annex to EN 1990, Table A1.2(B+C) DK NA.

<table>
<thead>
<tr>
<th>Limit state</th>
<th>STR/GEO</th>
<th>STR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Combination of actions</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>$\gamma_0$</td>
<td>1,0</td>
<td>1,0</td>
</tr>
</tbody>
</table>

The factor $\gamma_3$ takes into account the level of checking of the product. The reduced level of checking is not used.

Extended level of checking: $\gamma_3 = 0,95$
Normal level of checking: $\gamma_3 = 1,00$

The partial factors are determined in accordance with the National Annex to EN 1990, Annex F, *Partial factors for resistance*, where $\gamma_M = \gamma_1 \gamma_2 \gamma_3 \gamma_4$, where the values of $\gamma_{Mi}$ given above include the factor $\gamma_0$. 

___________________________________
Page 4 of 8
\[ \gamma_1 \text{ takes into account the type of failure; } \]
\[ \gamma_2 \text{ takes into account the uncertainty related to the design model; } \]
\[ \gamma_3 \text{ takes into account the extent of checking; } \]
\[ \gamma_4 \text{ takes into account the variation of the strength parameter or resistance. } \]

When determining \( \gamma_1 \), the following types of failure have been assumed:

- \( \gamma_{M0} \): Warning of failure with residual resistance
- \( \gamma_{M1} \): Warning of failure without residual resistance
- \( \gamma_{M2} \): No warning of failure

For accidental and seismic design situations the following values are used:

\[ \gamma_{M0} = 1,0 \]
\[ \gamma_{M1} = 1,0 \]
\[ \gamma_{M2} = 1,0 \]

6.1(1) NOTE 2B  Ultimate limit states, General
See 6.1(1)

6.3.2.3(2) Lateral torsional buckling curves for rolled sections or equivalent welded sections
\( f = 1 \). The determination of \( M_{cr} \) takes into account the moment distribution between lateral restraints. See also the complementary information.

6.3.3(5) Uniform members in bending and axial compression
Both Method 1 and Method 2 may be used to determine the values of the interaction factors \( k_{yy}, k_{yz}, k_{zy} \) and \( k_{zz} \). See also the complementary information.

6.3.4(1) General method for lateral and lateral torsional buckling of structural components
The relevance of using the method in 6.3.4 is to be evaluated for each case.

7.2.1(1)B Vertical deflections
For beams, the following values of the maximum deflection (\( w_3 \) in EN 1990, Figure A1.1) due to one variable action without allowance for impact, if any, may serve as guidance as to what may be regarded as acceptable deflections:

- floors \( l/400 \)
- roofs and external walls \( l/200 \)

Where \( l \) is:

- the span of simply supported and continuous beams;
- twice the projection of cantilevered structures.

The values apply both to main and secondary elements, but only the deflection of the element considered is to be used in the assessment.
For secondary sheeting in the form of uninsulated roof sheeting and for facade sheeting, the deflection due to permanent and variable actions should not exceed $l/90$.

For roof sheeting with external insulation and roofing felt, the deflection due to permanent and variable actions should not exceed:

- $l/150$ for $l < 4500$ mm
- $30$ mm for $4500$ mm $\leq l < 6000$ mm
- $l/200$ for $6000$ mm $\leq l$

### 7.2.2(1)B Horizontal deflections

For columns, the following numerical values of the maximum deflection of the column head due to one variable action may serve as guidance to what may be regarded as acceptable deflections:

- frames in buildings without cranes $h/150$
- columns in single-storey skeleton structures $h/300$
- columns in multi-storey skeleton structures, for each storey $h/300$
  for the total height $h_e/500$

Where

- $h$ is the height of the individual column
- $h_e$ is the total height of the building.

### BB.1.3(3)B  Hollow sections as members

Further information on buckling lengths of compression members should be found in textbooks.

### C.2.2(3) Selection of execution class

The execution class is selected on the basis of the consequences class.

<table>
<thead>
<tr>
<th>Consequences class</th>
<th>Type of action</th>
<th>Fatigue $b)$ or seismic $d)$</th>
</tr>
</thead>
<tbody>
<tr>
<td>CC3</td>
<td>EXC3 $c)$</td>
<td>EXC3 $c)$</td>
</tr>
<tr>
<td>CC2</td>
<td>EXC2</td>
<td>EXC3</td>
</tr>
<tr>
<td>CC1</td>
<td>EXC1/EXC2 $d)$</td>
<td>EXC2</td>
</tr>
</tbody>
</table>

$a)$ Seismic ductility classes are defined in DS/EN 1998-1: Low = DCL, medium = DCM, high = DCH.


$c)$ EXC4 should be used for structural components where the consequences of failure are particularly serious.

$d)$ EXC2 for welds. See C.2.2(4).
C.2.2(4) Selection of execution class
For the execution of welds, DS/EN 1993-1-8 specifies that a weld of at least quality level C (according to DS/EN ISO 5817) is normally required unless otherwise specified. Therefore, at least execution class EXC2 should be applied for the welded connections in the structure. For structures of consequences class CC1, EXC1 may be used for the fillet weld if the throat thickness of the fillet weld is increased by 20 %, and quality level C is applied with the exception that quality level D can be applied for "Undercut" (5011, 5012), "Overlap" (506), "Stray arc" (601) and "End crater pipe" (2025).
Complementary, non-contradictory information

3.2.4(1) Through-thickness properties
It is recommended that structural components subject to stress in the through-thickness direction should be protected against lamination according to DS/EN 10160, class S1.

5.2.2(8) Structural stability of frames
Detailed guidelines are not given for structural analyses of the stability of frames using a method based on equivalent buckling lengths. Guidance should be found in specialist literature or the method of analysis should be documented by other means.

6.2.2 Resistance of cross-sections - Section properties
For a long-threaded structural component, the gross cross section and the net cross section are taken as the stress area as defined in DS/EN 1993-1-8, 1.5. The connection at the end of the component should also conform to the design rules for bolted connections specified in DS/EN 1993-1-8.

6.3.2.3(2) Lateral torsional buckling curves – General case
Justification for changing 6.3.2.3(2) Lateral torsional buckling curves for rolled sections or equivalent welded sections
The specified method assumes (cf. ECCS Publication 119) that when calculating $M_{cr}$ and consequently $\lambda_{LT}$, a uniform moment distribution between the lateral restraints is taken into account corresponding to $\Psi = 1$ in Table 6.6, and not the real moment distribution as in 6.3.2.2. The real moment distribution has been taken into account by the factor $f$. The text of the change specifies that also when using this method, $M_{cr}$ is to be determined on the basis of the real moment distribution between the lateral restraints, and $f$ is taken as 1.

6.3.3(5) Uniform members in bending and axial compression
Method 1 is recommended for significant structures and where cost is decisive, and as a basis for the preparation for design programs.
Method 2 is recommended as a simpler method for less significant structures.
See also the national choice.

Annex B, Method 2 – Interaction factors $k_{ij}$ for interaction formula in 6.3.3(4)
Table B.3: Equivalent uniform moment factors $C_m$ in Tables B.1 and B.2
$M_i$ is to be obtained according to the value of bending moment diagram which yields a local extreme ($dM_i/dx = 0$) between end points of beam elements ($x = 0$ and $x = L$). Where a local extreme does not exist, $M_i$ is to be taken as the value obtained at the centre of the beam element.