National Annex to
DS/EN 1520:2011, Prefabricated reinforced components of
lightweight aggregate concrete with open structure with struc-
tural or non-structural reinforcement

Foreword
This national annex (NA) is a revision of DS/EN 1520 DK NA:2011 and replaces the latter on
2013-08-15. For a transition period until 2013-09-01, this National Annex as well as the previous
National Annex will be applicable. In addition editorial changes, major changes in content have
been made with respect to Annex C where \( \gamma_0 \) has been introduced.

Previous versions, addenda and an overview of all National Annexes can be found at
www.Eurocodes.dk

This national Annex (NA) lays down the conditions for the implementation in Denmark of EN 1520
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.

National provisions are nationally applicable values and options between methods as specified in
the standard as well as complementary information. Complementary information can also be found
in DS/INF 168, Supplementary guidelines for the use of EN 1520, Prefabricated reinforced compo-
nents of lightweight aggregate concrete with open structure.

This NA includes:

- an overview of possible national choices and complementary information;
- national choices;
- complementary (non-contradictory) information.

The numbering refers to the clauses of EN 1520 containing choices and/or complementary informa-
tion. To the extent possible, the heading/subject is identical to the heading of the clause, but as
references are at a more detailed level than the headings, the heading/subject has in several cases
been made more explicit.
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 document.

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NOTE
Unchanged: Choices and recommended values given in the standard are applied.

Not possible: National choices are not possible. The clause should not be included in the list in EN 1520, Foreword, of clauses where national choices are to be made.
National choices

5.1.1.1 Mechanical resistance - General
Actions appear from the EN 1991-1 series of standards with the associated Danish National Annexes.
Partial safety factors appear from Annex C of this NA.

5.3.5 Strength of joints
The strength of joints may be determined in accordance with DS/INF 168.

5.3.7 Reinforcement detailing
Permissible anchorage arrangements and minimum support lengths are specified in Annex A, clause A.9.

5.4.3 Support length
The manufacturer is to declare the minimum support length; however, it should be not less than 55 mm and at least that used in type testing.

5.5.1 Additional requirements for wall components - General
The minimum wall thickness is as follows
- structural walls in general $h \geq 70$ mm
- non-structural walls $h \geq 50$ mm
- structural hollow core walls $h \geq 100$ mm
- non-structural hollow core walls $h \geq 65$ mm

5.6.4.2 Embedding in a zone of normal concrete or lightweight concrete with closed structure (LC concrete)
Normal concrete and lightweight aggregate concrete with dense structure is to fulfil the requirements in EN 206-1 and the associated DS 2426.
$\Delta c_{\text{min,dur}} = 0$ mm.

A.4.1 Design assumptions
In structural design, the flexural strength can be applied as specified in A.6.3.3.3.

A.4.2 Stress-strain diagram for LAC
Partial safety factors to be used appear from Annex C of this NA.
The $\alpha$ factor is taken as 1.00 for all design situations.
A.5.1 Shear design for components predominantly under transverse load not requiring shear reinforcement
The design shear resistance, $V_{Rd1}$, is determined according to equation (A.10).

A.5.2 Shear design for components predominantly under transverse load requiring shear reinforcement
The design shear resistance, $V_{Rd3}$, is determined according to equation (A.17).

A.6.1 General
The loadbearing capacity of components may be calculated according to the specifications given in subclauses A.6.2, A.6.3 or A.6.4.
The slenderness ratio of components is to be below the limit specified in Figure A.4.

A.6.2 Method based on the Euler formula
The slenderness ratio of components is to be below the limit specified in Figure A.4.

Components can be considered to have three or four sided supports only if Note 2 is fulfilled and the joints between these components and the supporting components have sufficient strength and if the supporting components conform to the following requirements:
- their thickness is at least 75 mm;
- their height is equivalent to the height of the component to be supported;
- their width is at least 1/5 of their height;
- there should be no holes at a distance of at least 1/5 of their height in the zone closest to the supporting component.

A.6.3.3 Design of critical cross-section for compression and bending - Non-structurally reinforced cross-section
The loadbearing capacity of the walls can be verified by applying the method in (3)P, the value of $\alpha$ being taken as 1.0.

A.8.1.4 Punching
For concentrated loads acting on solid components or multilayer components, it is not necessary to consider punching, provided that the following conditions are met:
- load < 5 kN;
- thickness of component > 150 mm;
- loaded area > 10 000 mm$^2$.

In other cases the punching shear resistance can be assessed by a 1:1 distribution of loading through the concrete related to the plane of the tensile reinforcement as illustrated in Figure A.1 (DK).
The shear resistance $V_{Rd}$ in section I-I may be assessed according to sub-clauses A.5.1 or A.5.2.

**A.8.2.1.2 Chases**
Chases in walls for installations (pipes, cables and sockets etc.) are allowed to the extent provided for by the calculations of the structure or where they do not have an impact on the resistance.

**A.8.2.2 Solid walls**
The anchorage systems applied is to be documented by type testing and/or calculation. Anchorage of reinforcement is verified as stated in clause A.9.
See also the complementary (non-contradictory) information.

**A.9 Detailing of reinforcement**
The systems described in a), b), c), d), e), f), g) and h) can be used in Denmark, provided that the system was used in the initial type testing.
See also the complementary (non-contradictory) information.

**Annex C Recommended values for partial safety factors**
For structures built in Denmark the following partial safety factors for materials are to be used. Thus, the recommended values given in clauses C.2 and C.3 do not apply in Denmark.
Table C.3 DK NA – Partial safety factors for strength properties

**Structures, in situ**
- Compressive strength and modulus of elasticity of reinforced lightweight concrete
  \[ \gamma_c = 1.45 \cdot \gamma_0 \cdot \gamma_3 \]
- Compressive strength and modulus of elasticity of unreinforced lightweight concrete
  \[ \gamma_c = 1.60 \cdot \gamma_0 \cdot \gamma_3 \]
- Flexural strength of lightweight concrete
  \[ \gamma_c = 1.70 \cdot \gamma_0 \cdot \gamma_3 \]
- Strength and modulus of elasticity of reinforcement ¹)
  \[ \gamma_s = 1.20 \cdot \gamma_0 \cdot \gamma_3 \]
- Bond of reinforcement in lightweight concrete ¹)
  \[ \gamma_c = 1.70 \cdot \gamma_0 \cdot \gamma_3 \]
- Shear strength of joints
  \[ \gamma_c = 1.70 \cdot \gamma_0 \cdot \gamma_3 \]
- Cohesion
  \[ \gamma_c = 1.70 \cdot \gamma_0 \cdot \gamma_3 \]
- Friction coefficients
  \[ \gamma_c = 1.30 \cdot \gamma_0 \cdot \gamma_3 \]

**Precast concrete elements, calculation**
- Compressive strength and modulus of elasticity of reinforced lightweight concrete
  \[ \gamma_c = 1.40 \cdot \gamma_0 \cdot \gamma_3 \]
- Compressive strength and modulus of elasticity of unreinforced lightweight concrete
  \[ \gamma_c = 1.55 \cdot \gamma_0 \cdot \gamma_3 \]
- Flexural strength of lightweight concrete
  \[ \gamma_c = 1.60 \cdot \gamma_0 \cdot \gamma_3 \]
- Strength and modulus of elasticity of reinforcement ¹)
  \[ \gamma_s = 1.20 \cdot \gamma_0 \cdot \gamma_3 \]

**Precast concrete elements, performance testing**
- Testing leading to ductile failure ²)
  \[ \gamma_m = 1.20 \cdot \gamma_0 \cdot \gamma_3 \]
- Testing leading to ductile failure ²)
  \[ \gamma_m = 1.40 \cdot \gamma_0 \cdot \gamma_3 \]

This applies to strength, modulus of elasticity and bond in reinforcement, wall ties and other drilled in or embedded anchors.

²) This applies to testing of lightweight concrete elements, connections with failure of the lightweight concrete, wall ties and anchors with failure of the lightweight concrete.

Components subject to transverse load are assumed to exhibit ductile failure if
- yielding of the reinforcement at failure is documented by measurement;
- prior to failure, a uniformly distributed crack pattern occurs corresponding to the load applied;
- prior to failure, deflection exceeds 3/200 of the span.

Other failure modes are to be regarded as brittle failures. Failure of components subject to axial forces is always assumed to be brittle failure.
The factor $\gamma_0$ takes into account the combination of actions, cf. National Annex to EN 1990, Table A1.2(B+C) as stated in Table C.4 DK NA.

Table D.4 DK NA – Dependency of load case

<table>
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<tr>
<th>Limit state</th>
<th>STR/GEO</th>
<th>STR</th>
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<td>Combination of actions</td>
<td>$\gamma_0$</td>
<td>$1$</td>
</tr>
<tr>
<td>$K_{FI}$</td>
<td>$K_{FI}$</td>
<td>$1,2\cdot K_{FI}$</td>
</tr>
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</table>

NOTE: For structures not subject to geotechnical actions, verification can be achieved solely by applying combinations of actions 1 and 2.

Geotechnical actions are actions transmitted to the structure by the ground, fillings, standing water or ground-water. In addition to the weight, the actions from the ground and fillings are determined by the strength and deformation properties of the ground and fillings, e.g. expressed as the angle of friction. Examples of geotechnical actions include earth and water pressures on a wall structure.

The factor $\gamma_3$ takes account of the level of checking of the product as stated in Table C.5 DK NA.

Table C.5 DK NA – Dependency of level of checking

<table>
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<th>Level of checking $\gamma_3$</th>
<th>Reduced</th>
<th>Normal</th>
<th>Extended</th>
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<td>$\gamma_3$</td>
<td>$1,1$</td>
<td>$1,0$</td>
<td>$0,95$</td>
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</table>

The partial safety factors in Table C.3 DK NA are based on the guidelines for determining resulting partial safety factors in the ultimate limit state. The resulting partial safety factor is determined by

$$\gamma_M = \gamma_0 \cdot \gamma_1 \cdot \gamma_2 \cdot \gamma_3 \cdot \gamma_4,$$

where

- $\gamma_0$ applies to members forming part of geotechnical structures, cf. EN 1990, Table A.1.2(B+C), and Annex F
- $\gamma_1$ takes into account the type of failure, see Table C.6 DK NA;
- $\gamma_2$ takes into account the uncertainty related to the design model;
- $\gamma_3$ takes into account the extent of checking, see Table C.5 DK NA;
- $\gamma_4$ takes into account the variation of the strength parameter or resistance.
When determining $\gamma_1$, the following types of failure have been assumed:

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<td>Flexural strength of lightweight concrete</td>
<td>No warning of failure</td>
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<tr>
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<td>Friction coefficients</td>
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<td>Compressive strength and modulus of elasticity of reinforced lightweight concrete</td>
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1) See Note 1) to Table C.3 DK.
2) See Note 2) to Table C.3 DK NA

When considering the serviceability limit state, $\gamma_m = 1,0$ is assumed.
Complementary (non-contradictory) information

4.3 Reinforcement steel
The following is added to the clause:

Regarding reinforcement steel according to EN 10080: “Reinforcement steel is either to be CE marked or manufactured in accordance with the requirements specified in EN 10080, Annex ZA, and the production/product is to be certified according to the requirements of Annex ZA. Where the product is not CE marked, the certification body and the testing laboratory is to be accredited to the standards concerned by an accreditation body that has signed the Multilateral Agreement of European Co-operation for Accreditation for the field in question.

After straightening, coils supplied according to EN 10080 are to be certified to the requirements of EN 10080 for the properties which are changed by the straightening process, in conformity with the requirements for straightened material in EN 10080.”

5.1.1.1 Properties and requirements of components – Mechanical resistance - General
The design methods in Annex A and Annex B provide the necessary safety level in combination with the nationally specified partial safety factors given in Annex C. It is thus possible to verify a design by applying one annex or a combination of both annexes.

A.8.2.2 Solid walls
When verifying the resistance of the structure, care is to be taken to consider eccentricities and deformation as a result of manufacture and erection.
See also the national choice.

A.9 Detailing of reinforcement
Other calculation methods for the determination of anchorage can be found in DS/INF 168.
See also the national choice.