DS/EN 1520 DK NA:2013

National Annex to

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

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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 γ_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 components 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 information. 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.

Clause	Subject	National choice	Complementary information
4.3	Reinforcement steel	Unchanged	Complementary information
5.1.1.1	Mechanical resistance - General	National choice	Complementary information
5.3.5	Strength of joints	National choice	
5.3.7	Reinforcement detailing	National choice	
5.4.3	Support length	National choice	
5.5.1	Additional requirements for wall components - General	National choice	
5.6.2	Minimum cover with regard to bond	Not possible	
5.6.4.2	Embedding in a zone of normal concrete or lightweight concrete with closed structure (LC concrete)	National choice	
7.3	Actions	Actions appear from the EN 1991-1 series of standards with the associated Danish National Annexes	
A.3	Partial safety factors	See national choice in Annex C	
A.4.1	Design assumptions	National choice	
A.4.2	Stress-strain diagram for LAC	National choice	
A.4.3	Stress-strain diagram for reinforcement steel	See national choice in Annex C	
A.5.1	Shear design for components predominantly under transverse load not requiring shear reinforcement	National choice	
A.5.2	Shear design for components predominantly under transverse load requiring shear reinforcement	National choice	
A.6	Ultimate limit state induced by	Not possible	

Clause	Subject	National choice	Complementary information
	structural deformation (buckling)		
A.6.1	General	National choice	
A.6.2	Method based on the Euler formula	National choice	
A.6.3.3.3	Design of critical cross-section for compression and bending - Non-structurally reinforced cross-section	National choice	
A.8.1.4	Punching	National choice	
A.8.2.1.2	Chases	National choice	
A.8.2.2.2	Solid walls	National choice	Complementary information
A.9	Detailing of reinforcement	National choice	
Annex B	Design of components by testing	Applied as a normative annex	
B.3.2	Brittle and ductile failure	See national choice in Annex C	
B.3.3	Partial safety factors	See national choice in Annex C	
B.4.3.1	Loadbearing capacity	See national choice in Annex C	
B.4.3.3	Design loadbearing capacity for centric and eccentric compression forces	See national choice in Annex C	
Annex C	Recommended values for partial safety factors	National choice	

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.
$\Delta c_{min,dur} = 0$ 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 α 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.6.3.3.3 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 α 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).

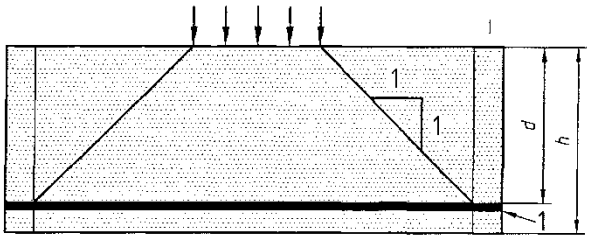

Figure A.1 (DK) – Distribution of concentrated load

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.8.2.2.2 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 γ_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

Limit state	**STR/GEO**				**STR**
Combination of actions	1	2	3	4	5
γ_0	1,0	1,0	K_{FI}	K_{FI}	$1{,}2 \cdot K_{FI}$

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 γ_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

Level of checking	Reduced	Normal	Extended
γ_3	1,1	1,0	0,95

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

- γ_0 applies to members forming part of geotechnical structures, cf. EN 1990, Table A.1.2(B+C), and Annex F
- γ_1 takes into account the type of failure, see Table C.6 DK NA;
- γ_2 takes into account the uncertainty related to the design model;
- γ_3 takes into account the extent of checking, see Table C.5 DK NA;
- γ_4 takes into account the variation of the strength parameter or resistance.

When determining γ_1, the following types of failure have been assumed:

Table C.6 DK NA – Assumed types of failure for the determination of γ_1

Structures, in situ	
Compressive strength and modulus of elasticity of reinforced lightweight concrete	Warning of failure without residual resistance
Compressive strength and modulus of elasticity of unreinforced lightweight concrete	No warning of failure
Flexural strength of lightweight concrete	No warning of failure
Strength and modulus of elasticity of reinforcement [1)]	Warning of failure without residual resistance
Bond of reinforcement in lightweight concrete [1)]	No warning of failure
Shear strength of joints	No warning of failure
Cohesion	No warning of failure
Friction coefficients	Warning of failure without residual resistance
Precast concrete elements, calculation	
Compressive strength and modulus of elasticity of reinforced lightweight concrete	Warning of failure without residual resistance
Compressive strength and modulus of elasticity of unreinforced lightweight concrete	No warning of failure
Flexural strength of lightweight concrete	No warning of failure
Strength and modulus of elasticity of reinforcement [1)]	Warning of failure without residual resistance
Precast concrete elements, performance testing	
Testing leading to ductile failure [2)]	Warning of failure without residual resistance
Testing leading to ductile failure [2)]	No warning of failure

[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, γ_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.8.2.2.2 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.