Translation of:

National technical approval (abZ)/
General construction technique permit (aBG)

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Applicant:
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Subject of this approval/permit
Carbon reinforcement grid solidian GRID for the reinforcement of concrete components with nonmetallic reinforcement

The above-mentioned subject of regulation is hereby generally approved by the Deutsches Institut für Bautechnik, Berlin, for Germany and its federal states. This approval/permit comprises twelve pages and four annexes.

This document contains a translation of the original German version of the approval/permit Z-1.6-308, which has not been reviewed by Deutsches Institut für Bautechnik. Deutsches Institut für Bautechnik (DIBt) is the German technical approval body and a European Assessment Body.

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I GENERAL PROVISIONS

1 This approval/permit is proof of the usability or applicability of the subject matter of the regulation within the meaning of the Building Codes of the federal states.

2 This approval/permit does not replace the permits, approvals and certificates required by law for the implementation of building projects.

3 This approval/permit is issued without prejudice to the rights of third parties, in particular private property rights.

4 Copies of this approval/permit must be made available to the user of the subject matter of the regulation, notwithstanding any further provisions in the "Special provisions". In addition, the user of the subject matter of the regulation must be informed that this approval/permit must be available at the place of use or application. Copies must also be made available to the authorities involved on request.

5 This approval/permit may only be reproduced in full. Publication of extracts requires the approval of Deutsches Institut für Bautechnik. Texts and drawings in advertising material may not contradict this approval/permit; translations must contain the note "Translation of the original German version not approved by Deutsches Institut für Bautechnik".

6 This approval/permit is issued on a revocable basis. The provisions may be supplemented and amended at a later date, in particular if new technical findings make this necessary.

7 This approval/permit refers to the information and documents provided by the applicant. Any changes to this basis are not covered by this approval/permit and must be disclosed to Deutsches Institut für Bautechnik without delay.

II SPECIAL PROVISIONS

1 Subject matter and scope of use and application

1.1 Subject of approval and area of usage

The subject of approval are carbon reinforcement grids solidian GRID made of epoxy resin-impregnated carbon fiber strands.

The rectangular grid structure is achieved by overlapping the warp yarns in the production direction (0°) and the weft yarns at right angles to the production direction (90°) by connecting them via stitch yarns at the intersections of the grid on a warp knitting machine with 0° and weft yarn feed.

The possible configurations for the solidian GRID carbon reinforcement grids are described in section 2.1.1.

The carbon reinforcement grid solidian GRID may be used as single or multi-layer tensile reinforcement for concrete components in compliance with the provisions in section 1.2.

The production and monitoring of factory-made precast concrete elements with solidian GRID carbon reinforcement grid is not regulated in DIN 1045-4.

1.2 Subject of approval and scope of application

The subject of approval is the planning, dimensioning and execution of reinforced concrete components using solidian GRID carbon reinforcement grids.

The solidian GRID carbon reinforcement grids may be used as single or multi-layer tensile reinforcement for concrete components under the following conditions:

- For load-bearing purposes (as statically effective reinforcement), a combination of solidian GRID carbon reinforcement grids with reinforcing steel and/or prestressing steel is not permitted in a component.
- A combination with steel reinforcement is possible when using solidian GRID carbon reinforcement grids exclusively for non-statically effective purposes. Direct contact between solidian GRID carbon reinforcement grid and steel reinforcement must be avoided to prevent contact corrosion.
- The DAfStb guideline "Concrete components with nonmetallic reinforcement", Part 1, Section 5.1.1, (R15) applies to installation in an elastically bent state. The minimum permissible radius of curvature is 350 mm.
- Forming in accordance with the DAfStb guideline "Concrete components with nonmetallic reinforcement", Part 1, Section 8.3, (R8) or Part 3, Section 6.3, (1), c) of the solidian GRID carbon reinforcement grid is not permitted.
- The DAfStb guideline "Concrete components with non-metallic reinforcement", Part 1, applies to the minimum thickness of components. However, the minimum thickness of concrete components with solidian GRID carbon reinforcement grid must not be less than 30 mm.
- Normal concrete is used in accordance with DIN EN 206-1 in conjunction with DIN 1045-2 in the concrete strength classes C30/37 to C70/85. Application for concrete strengths higher than C70/85 is possible if the values of a C70/85 are used for the compressive strength of the concrete and the bond strength.
- The diameter of the largest grain of the aggregate of the concrete used must not exceed 16 mm.
- The components are subjected to quasi-static and/or predominantly static loads.
- The specifications according to DIN EN 1992-1-1 in conjunction with DIN EN 1992-1-1/NA, Table 4.1, Sections 5 and 6 (exposure classes XF and XA) and Section 4.4.1.2 (13) (exposure classes XM) apply to the concrete attack.
- The component temperature must not fall below -20 °C and must not exceed 40 °C on an annual average. Climate-related short-term temperature increases of up to 80°C are possible.

- This temperature range may also be briefly exceeded up to 80°C if the solidian GRID carbon reinforcement grids are still unloaded during the hardening of the concrete.

The components made of normal concrete up to strength class C 50/60 reinforced with the carbon reinforcement grids meet the requirements for the fire behavior of building materials of building material class A2 according to DIN 4102-1 if a minimum concrete cover cmin,b of the carbon reinforcement on all sides is maintained in accordance with section 3.1. The standard concrete used must meet the requirements of DIN EN 1992-1-2, section 4.5.1 in conjunction with DIN EN 1992-1-2/NA to prevent concrete spalling in the event of fire and must be manufactured using a cement without pozzolanic components and additives as well as latent hydraulic additives.

Concrete components reinforced with carbon reinforcement grids that do not comply with the above requirements meet the fire behavior requirements of building material class B2 according to DIN 4102-1 or class E according to DIN EN 13501-1.

Concrete components with carbon reinforcement grids and fire resistance requirements are not covered by this approval/permit.

2 Provisions for the construction product(s)

2.1 Properties and composition

2.1.1 Grid families of solidian GRID carbon reinforcement grids

The approval/permit applies to the following grid families:

- Grid family 1 (see Appendix 1 for grids of family 1 that can be used according to the approval/permit):
  Grid with 1-roving fiber strands (nominal fiber cross-sectional area per fiber strand 1,81 mm²) in warp and weft direction with grid widths in both directions from 21 mm to 76 mm,
- Grid family 2 (see Appendix 2 for grids of family 2 that can be used in accordance with the approval/permit):
  Grids with 2-roving fiber strands (nominal fiber cross-sectional area per fiber strand 3,62 mm²) in warp and weft direction with grid widths in both directions from 38 mm to 76 mm,
- Grid family 3 (see Appendix 3 for grids of family 3 that can be used according to the approval/permit):
  Grids with 1-roving fiber strands in one direction (warp or weft direction) and 2-roving fiber strands in the other direction (weft or warp direction) with grid widths for the 1-roving fiber strands of 21 mm to 76 mm and for the 2-roving fiber strands of 38 mm to 76 mm.

The carbon reinforcement grid solidian GRID is designated in accordance with the DAfStb guideline "Concrete components with nonmetallic reinforcement", Part 2, Section 4.1.1.

The properties of the fiber strands of the individual grid families are given in Table 1 and in Appendices 1 to 3.

Table 1: Properties of the fiber strands in warp and weft direction for grid families 1 to 3

Grid family Carbon grid	Properties	Warp thread	Weft thread
Grid family 1	Fiber strand type	1R	1R
	Cross-sectional area of a fiber strand $A_{f,nm}$ [mm²]	1,81	1,81
	Grid width s [mm]	$21 \leq s \leq 76$	$21 \leq s \leq 76$
	Nominal cross-sectional area A_{nm} [mm²]	4,4	4,4
	Nominal diameter $Ø_{nm}$ [mm]	2,37	2,37
	Nominal cross-sectional area per m width a_{nm} [mm²/m]	$\frac{1000}{s} A_{nm}$	$\frac{1000}{s} A_{nm}$
Grid family 2	Fiber strand type	2R	2R
	Cross-sectional area of a fiber strand $A_{f,nm}$ [mm²]	3,62	3,62
	Grid width s [mm]	$38 \leq s \leq 76$	$38 \leq s \leq 76$
	Nominal cross-sectional area A_{nm} [mm²]	8,8	8,8
	Nominal diameter $Ø_{nm}$ [mm]	3,35	3,35
	Nominal cross-sectional area per m width a_{nm} [mm²/m]	$\frac{1000}{s} A_{nm}$	$\frac{1000}{s} A_{nm}$
Grid family 3 (warp and weft direction can also be inter-changed)	Fiber strand type	1R	2R
	Cross-sectional area of a fiber strand $A_{f,nm}$ [mm²]	1,81	3,62
	Grid width s [mm]	$21 \leq s \leq 76$	$38 \leq s \leq 76$
	Nominal cross-sectional area A_{nm} [mm²]	4,4	8,8
	Nominal diameter $Ø_{nm}$ [mm]	2,37	3,35
	Nominal cross-sectional area per m width a_{nm} [mm²/m]	$\frac{1000}{s} A_{nm}$	$\frac{1000}{s} A_{nm}$

The carbon grids must be impregnated with the impregnating agent (see 2.1.2) and sufficiently cross-linked so that, depending on the grid family, the characteristic values in Tables 2 and 3 are achieved.

The width and length of the carbon reinforcement grids depend on the knitting machine used for production and the manufacturing process.

The composition and properties of the carbon fiber strands and the impregnation must comply with the specifications deposited with Deutsches Institut für Bautechnik.

Table 2: Characteristics of the impregnated fiber strands of the solidian GRID carbon reinforcement grid

	Properties of the impregnated fiber strands (warp and weft fiber strands)	Values of the roving strand types in relation to nominal cross-sections and nominal diameters	
		1R	**2R**
1	Characteristic tensile strength of the impregnated fiber strand* [N/mm²] $f_{nm,k}$	1250 MPa	1200 MPa
2	Modulus of elasticity of the impreg-nated fiber strand* [N/mm²] $E_{\mathrm{nm,m}}$	99000 MPa	97000 MPa
3	Characteristic value of the elongation at break of the impregnated fiber strand $\varepsilon_{nm,uk}$	12,6 ‰	12,4 ‰
4	Characteristic value of the bond strength for anchoring f_{bk}	1,7 MPa	2,9 MPa
5	Characteristic value of the applicable reinforcement stress in the anchorage check	885 MPa	1020 MPa
6	Characteristic bond strength $\tau_{bm,k}$ for the verification of the bond in the serviceability limit state	7,1 MPa	5,9 MPa
7	Minimum anchoring length $l_{b,min}$	42 mm [a)]	76 mm [a)]
8	Minimum lap length $l_{0,min}$	63 mm (≥ 3xgrid width s)	114 mm (≥ 3xgrid width s)
9	Minimum lap length for transferring $f_{nm,k}$ in the lap joint	700 mm	500 mm
10	Transferable tensile stresses $\sigma_{nm,lo,k}$ for smaller lap lengths l_0 (intermediate values are to be interpolated linearly): $l_{0,min}$ 250mm 500mm 700mm	 669 N/mm² 815 N/mm² 977 N/mm² 1250 N/mm²	 679 N/mm² 855 N/mm² 1200 N/mm² --

[a)] To prevent the failure mechanism from changing to pure pull-out, it must be ensured that at least one fiber strand is located within the anchorage length in the transverse direction.

Table 3: Coefficients for the properties of the impregnated fiber strands of the solidian GRID carbon reinforcement grid

	Coefficient for the properties of the impregnated fiber strands (warp and weft fiber strands)	Values of the roving strand types	
		1R	2R
1	Reduction factor of the tensile strength for temperature exposure α_{Tt}	1 at -20°C ≤ T ≤ 70°C 0,95 at 70°C < T ≤ 80°C	1 at -20°C ≤ T ≤ 70°C 0,90 at 70°C < T ≤ 80°C
2	Reduction factor α_{nmt} for the consideration of durability influences and long-term stresses on the tensile strength	0,83	0,83
3	Reduction factor for the bond of the textile reinforcement in the concrete for temperature effect α_{Tb}	1 at -20°C ≤ T ≤ 70°C 0,95 at 70°C < T ≤ 80°C	1 at -20°C ≤ T ≤ 70°C 0,90 at 70°C < T ≤ 80°C
4	Reduction factor α_{nmb} for the consideration of durability influences and long-term stresses on the bond strength	0,83	0,83

2.1.2 Impregnating agent

The same epoxy resin is used as the impregnating agent for all grid families in this approval/permit. The fiber strands are impregnated with this resin under defined manufacturing conditions. This coats the individual filaments of the rovings and bonds them together, creating the internal bond between the filaments in the rovings.

The composition and properties of the impregnating agents must comply with the specifications deposited with Deutsches Institut für Bautechnik.

2.1.3 Fire behavior

When installed and tested in accordance with DIN EN ISO 11925-2, backed with a gypsum board in accordance with DIN EN 13238, the carbon reinforcement grids meet the fire behavior requirements for class E building materials in accordance with DIN EN 13501-1.

2.2 Manufacture, packaging, transport, storage, labeling

2.2.1 Manufacture

2.2.1.1 Carbon reinforcement grid solidian GRID

The carbon grids may only be manufactured from the components deposited in accordance with sections 2.1.1 and 2.1.2 in the plants deposited with the DIBt [1].

The carbon grids must be manufactured in such a way that the carbon fiber strands are aligned in the warp and weft direction without waviness, completely impregnated with the impregnating agent and sufficiently cross-linked.

The carbon grids can be supplied as flat single grids or on rolls with a minimum inner roll diameter of 70 cm.

2.2.1.2 Impregnating agent

The grids may only be impregnated with the impregnating agent according to section 2.1.2 in the plants deposited with the DIBt [1].

[1] The exact designation of the plants is deposited with the Deutsches Institut für Bautechnik.

2.2.2 Packaging, transportation, storage

2.2.2.1 Carbon reinforcement grid solidian GRID

The DAfStb guideline "Concrete components with nonmetallic reinforcement", Part 3, Section 6.3, (4) to (6) applies,

For the solidian GRID according to this approval/permit is $T_{max,0}$ = 80 °C.

2.2.3 Labeling

2.2.3.1 General information

The construction products or their packaging must be marked by the manufacturer with the conformity mark (Ü mark) in accordance with the conformity mark regulations of the federal states. The mark may only be affixed if the requirements in section 2.3 are met.

2.2.3.2 Carbon reinforcement grid solidian GRID

The weatherproof instruction leaflet on the packaging of the hardened carbon grids must be clearly marked with the following information:

- Grid designation according to DAfStb guideline " Concrete components with nonmetallic reinforcement", Part 2, Section 4.1.1,
- Production batch and/or production date,
- Only for cuts for drawing parts: Confirmation of the dimensional accuracy of the grids according to the drawing,
- building authority mark of conformity stating the approval/permit number.
- manufacturing plant.

2.3 Confirmation of conformity

2.3.1 General information

Confirmation of conformity of the construction products in accordance with sections 2.1.1 with the provisions of the general building approval covered by the approval/permit must be provided for each manufacturing plant with a declaration of conformity by the manufacturer on the basis of a factory production control and a certificate of conformity by a certification body recognized for this purpose as well as regular external surveillance by a recognized surveillance body in accordance with the following provisions.

The manufacturer of the construction product must involve a recognized certification body and a recognized inspection body for the issuing of the certificate of conformity and external monitoring, including the product tests to be carried out.

The manufacturer must submit the declaration of conformity by marking the construction products with the mark of conformity (Ü mark) with reference to the intended use.

The certification body shall provide the Deutsches Institut für Bautechnik with a copy of the certificate of conformity issued by it and a copy of the initial test report in accordance with section 2.3.3.

2.3.2 Factory production control

In each manufacturing plant of the products according to section 2.1.1 a factory production control shall be set up and carried out. Factory production control is understood to mean the continuous surveillance of production to be carried out by the manufacturer to ensure that the products manufactured by him comply with the provisions of this general building approval.

As part of the factory production control of the carbon reinforcement grid, the tests must be carried out in accordance with the test and monitoring plan provided.

The results of the factory production control in the manufacturing plants of the carbon reinforcement grid in accordance with section 2.1.1 must be recorded and evaluated. The records must contain at least the following information:

- Designation of the construction product or the basic material, the type used and the components
- Type of inspection or test
- Date of manufacture and testing of the construction product or source material or components
- Result of the checks and tests and, where applicable, comparison with the requirements
- Signature of the person responsible for factory production control

The records must be handed over to the applicant, kept by him for at least five years and, if required, submitted to the surveillance body responsible for surveillance by an approved body. They shall be submitted to Deutsches Institut für Bautechnik and the competent supreme building supervisory authority upon request.

If the test result is unsatisfactory, the manufacturer must immediately take the necessary measures to rectify the defect. Construction products that do not comply with the requirements must be handled in such a way that any confusion with compliant products is ruled out. Once the defect has been rectified, the relevant test must be repeated without delay, insofar as this is technically possible and necessary to prove that the defect has been rectified.

2.3.3 Surveillance by an approved body

In each manufacturing plant of the carbon reinforcement grid according to section 2.1.1, the factory production control must be checked regularly by surveillance by an approved body, but at least twice a year.

As part of the third party inspection, an initial inspection of the construction products must be carried out and samples must be taken for random testing.

For surveillance by an approved body of the carbon reinforcement grid, the tests must be carried out in accordance with the test and monitoring plan provided.

Sampling and testing are the responsibility of the approved body for surveillance.

The results of certification and surveillance must be kept for at least five years. They shall be submitted by the approved body or the surveillance body to Deutsches Institut für Bautechnik, the competent supreme building supervisory authority and the applicant upon request.

3 Provisions for planning, dimensioning and execution

3.1 Planning

The concrete components using the carbon reinforcement grid must be planned in compliance with the Technical Building Regulations, unless otherwise specified below.

In addition to the provisions in section 1.2, the following boundary conditions must be observed:

- The regulations of the DAfStb guideline "Concrete components with non-metallic reinforcement", Part 1, apply.
- The minimum concrete cover $c_{min,b}$ required for the bond is 14 mm for all grid families.
- The minimum concrete cover is c_{min} = max(d_g + 5 mm, $c_{min,b}$ = 14 mm).
- The following applies to the minimum component thickness:
  $h_{min} = (2 * c_{min} + 2 * \Delta c_{dev} + n_G * h_G + (n_G - 1) * s_v)$:
  - h_G the grid height of the grid used in accordance with Annexes 1 to 3,
  - s_v = max {$c_{min,b}$; 1,5 d_g } the distance between the grid layers according to DAfStb guideline "Concrete components with nonmetallic reinforcement", Part 1, Section 8.2, (2) and
  - Δc_{dev} the allowance for tolerance according to DAfStb guideline "Concrete components with nonmetallic reinforcement", Part 1, Section 4.4.1.3 (see also the last item in the list in 3.1).

  A component thickness of 30 mm is permissible for components with a centrally arranged grid reinforcement layer.
- In the anchoring area of the solidian GRID carbon reinforcement grid, it must be ensured that at least one fiber strand is within the anchoring length in the transverse direction.
- A maximum of 6 grid layers ($n_G \leq 6$) may be arranged in a tension zone. The clear spacing between the grids must comply with the DAfStb guideline "Concrete components with nonmetallic reinforcement", Part 1, Section 8.2 (2) and the fiber strands of the individual grid layers must lie on top of each other.
- Only components for which a calculated shear force reinforcement is not required may be reinforced with solidian GRID carbon reinforcement grids.
- The last sentence of DAfStb guideline Part 1, Section 4.4.1.3, (3), is replaced by: The reduction must not fall below the minimum dimension of the retention dimension of $\Delta c_{dev} \geq | \Delta c_c | - | \Delta c_{min,b} |$. Here, Δc_c is the limit value for the deviation of the static height according to Fig. R9-1 and $\Delta c_{min,b}$ = 2 mm is the limit value for the deviation from the minimum concrete cover $c_{min,b}$ = 14 mm.

3.2 Dimensioning

The concrete components using the carbon reinforcement grid must be designed in accordance with the Technical Building Regulations, unless otherwise specified below.

The DAfStb guideline "Concrete components with nonmetallic reinforcement", Part 1, also applies to the design.

All relevant design parameters of the solidian GRID carbon reinforcement grids that can be used in accordance with this approval/permit are specified in Annexes 1 to 3 in accordance with DAfStb Guideline "Concrete components with nonmetallic reinforcement", Part 2, Section 4.1.3.

3.3 Fire behavior

The components made of normal concrete up to strength class C 50/60 produced with the carbon reinforcement grids are non-combustible building materials (building material class DIN 4102-A2) if the provisions in section 1.2 (penultimate paragraph) of this certificate are complied with and may be used in areas in which the building regulations stipulate that the building materials used must be "non-combustible", "flame-retardant" or "normally flammable".

If the requirements for the minimum concrete cover on all sides $c_{min,b}$ in accordance with section 3.1 or for normal concrete in accordance with section 1.2 (penultimate paragraph) are not met, the concrete components may only be installed in areas in which the building materials used are required to be "normally flammable".

3.4 Execution

The concrete components using the carbon reinforcement grid must be executed in compliance with the Technical Building Regulations, unless otherwise specified below.

The DAfStb guideline "Concrete components with nonmetallic reinforcement", Part 3, Sections 1 to 8 and 10 also applies. Forming in accordance with the DAfStb guideline "Concrete components with nonmetallic reinforcement", Part 3, Section 6.3, (1), c) of the solidian GRID carbon reinforcement grid is not permitted.

The following furthermore applies:

- Only personnel who have been instructed by the manufacturer in the correct handling and safety instructions for using the solidian GRID carbon reinforcement grid may be used to carry out the reinforcement and concreting work.
- The solidian GRID carbon reinforcement grids must not be walked on directly, fold or subjected to sharp transverse pressures.
- The solidian GRID carbon reinforcement grids may be cut to size according to the manufacturer's instructions.
- The application of the allowance for tolerance according to 3.1, last indent or according to DAfStb guideline "Concrete components with nonmetallic reinforcement", Part 1, Section 4.4.1.3, (3) is excluded (see also DAfStb guideline "Concrete components with nonmetallic reinforcement", Part 1, NA.10.4).
- In-situ concrete components can be produced using the laminating process or the casting process.

3.4.1.1 Production of in-situ concrete components using the lamination method

This method is only suitable for horizontal components.

When concreting, the DAfStb guideline "Concrete components with nonmetallic reinforcement", Part 3, Section R8.4.7 must be observed in particular.

The decisive factor in the laminating process is that the layers are applied in wet method and the reinforcement remains in its planned position.

3.4.1.2 Production of in-situ concrete components using the casting process

This method is suitable for horizontal, inclined and vertical components and corresponds to traditional concreting.

When concreting, the DAfStb guideline "Concrete components with nonmetallic reinforcement", Part 3, Section 8 with the exception of Section R8.4.7.

If there is little experience or uncertainty regarding the behavior of the solidian GRID carbon reinforcement grids during concreting, a test component should be concreted (see Appendix 4) to check whether the selected concreting conditions (spacing of the spacers, consistency of the concrete, concreting speed, drop height of the concrete, etc.) are suitable for complying with the tolerances specified in the project for the positional deviation of the solidian GRID carbon reinforcement grids.

Normative references

DAfStb guideline for concrete components with non-metallic reinforcement	Part 1: Design and construction; Part 2: Reinforcement products; Part 3: Notes on construction; Part 4: Recommendations for test methods; Part 5: Notes on required verifications for the usability of the construction products (non-metallic reinforcement) and the applicability of the construction type; Publisher: Beuth; 2024-01
DIN EN 206-1:2001-07	Concrete - Part 1: Specification, performance, production and conformity
DIN 1045-2:2008-08	Concrete, reinforced and prestressed concrete structures - Part 2: Concrete - Specification, performance, production and conformity - Application rules for DIN EN 206-1
DIN EN 1992-1-1:2011-01	Eurocode 2: Design of concrete structures - Part 1-1: General rules and rules for buildings; German version EN 1992-1-1:2004 + AC:2010
DIN EN 1992-1-1/NA:2013-04	National Annex - Nationally determined parameters - Eurocode 2: Design of concrete structures - Part 1-1: General rules and rules for buildings
DIN 4102-1:1998-05	Fire behavior of building materials and building components - Part 1: Building materials; concepts, requirements and tests
DIN EN 1992-1-2:2010-12	Eurocode 2: Design of concrete structures - Part 1-2: General rules - Structural fire design; German version EN 1992-1-2:2004 + AC:2008
DIN EN 1992-1-2/NA:2010-12	National Annex - Nationally determined parameters - Eurocode 2: Design of concrete structures - Part 1-2: General rules - Structural fire design
DIN EN ISO 11925-2:2020-07	Reaction to fire tests - Ignitability of products subjected to direct impingement of flame - Part 2: Single-flame source test (ISO 11925-2:2020); German version EN ISO 11925-2:2020
DIN EN 13238:2010-06	Reaction to fire tests for building products - Conditioning procedures and general rules for selection of substrates; German version EN 13238:2010
DIN EN 13501-1:2019-05	Fire classification of construction products and building elements - Part 1: Classification using data from reaction to fire tests; German version EN 13501-1:2018

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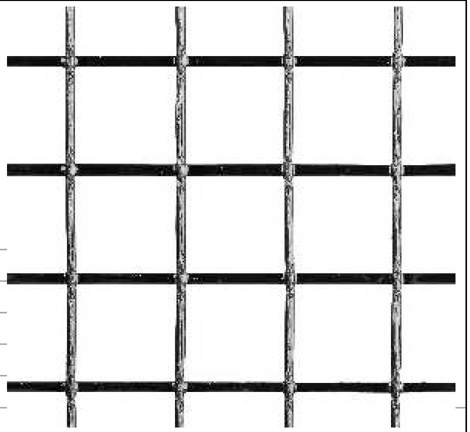
solidian. reinforcing the future

solidian GRID Q47-C-EP-s38-F145



Symmetrical, bidirectional reinforcement grid (type Q) made of media-resistant carbon fiber composite material for the reinforcement of concrete components with predominantly static loads in accordance with German national technical approval/construction technique permit Z-1.6-308

Material

Fiber material	C (Carbon)
Impregnating agent	EP (Epoxy resin)
Color	schwarz
Surface finish	smooth
Bending stiffness class	III, stiff
Validity for concrete strength classes	C30/37 to C70/85

Chemical resistance of the reinforcement in relation to the exposure classes in accordance with DIN EN 206-1 in conjunction with DIN 1045-2	XD3	Chlorides, except seawater
	XS3	Chlorides from seawater
	XA3	Chemical attack

Geometry and structure

			Unit	Value	Tolerance
	Directions of the fiber strands	longitudinal	[°]	0	± 5°
		transversal		90	± 5°
f_h	Mean value of fiber strand width	longitudinal	[mm]	3,5	± 10%
		transversal		4,2	± 10%
f_v	Mean value of fiber strand height	longitudinal	[mm]	1,9	± 10%
		transversal		1,8	± 10%
f_{nm}	Nominal diameter	longitudinal	[mm]	2,37	-
		transversal		2,37	-
A_{nm}	Nominal cross-sectional area per fiber strand	longitudinal	[mm²]	4,4	-
		transversal		4,4	-
a_{nm}	Nominal cross-sectional area per meter	longitudinal	[mm²/m]	116	-
		transversal		116	-
$A_{f,nm}$	Fiber cross-sectional area per fiber strand	longitudinal	[mm²]	1,81	-
		transversal		1,81	-
$a_{f,nm}$	Fiber cross-sectional area per meter	longitudinal	[mm²/m]	47	-
		transversal		47	-
s	Grid width	longitudinal	[mm]	38	± 3 mm
		transversal		38	± 3 mm
s_l	Clear distance of the fiber strands	longitudinal	[mm]	34,2	± 10%
		transversal		34,9	± 10%
h_G	Grid height (average value of the maximum height)		[mm]	2,3	± 10%
g	Weight per unit area of the non-metallic reinforcement		[g/m²]	309	± 10%
$\kappa_{ü}$	Degree of coverage of the mesh		[%]	18,9	-
r_{min}	Minimum permissible radius of curvature		[mm]	350	-

Material properties

			Unit	Value	Tolerance
r	Bulk density of the fiber composite material		[g/cm³]	1,30	-
α	Coefficient of thermal expansion	along the fiber	[10^{-6} 1/K]	0,5	-
T_{g0}	Glass transition temperature (DMA)		[°C]	≥ 110	-
	Recommended operating temperature range		[°C]	-20 bis +80	-
	Building material class reinforcement grid acc. to DIN EN 13501-1		[-]	E, normally flammable	-

Carbon reinforcement grid solidian GRID for the reinforcement of concrete components with nonmetallic reinforcement	**Appendix 1** **Page 1 of 4**
Grid family 1: **solidian** GRID Q47-C-EP-s38-F145	

+++ Translation of the original German version not approved by Deutsches Institut für Bautechnik +++

Translation of:

National technical approval (abZ)/
General construction technique permit (aBG)

No. Z-1.6-308 dated August 1, 2024 - Translation version: 01 | 09.10.2024

Mechanical properties			Unit	Value	Tolerance
$f_{nm,k}$	Characteristic short-term tensile strength related to the nominal cross-sectional area	longitudinal	[MPa]	1.250	-
		transversal		1.250	-
E_{nm}	Young's modulus related to the nominal cross-section	longitudinal	[MPa]	99.000	-
		transversal		99.000	-
$f_{f,nm,k}$	Characteristic short-term tensile strength related to the fiber cross-sectional area	longitudinal	[MPa]	3.039	-
		transversal		3.039	-
$E_{f,nm,m}$	Mean modulus of elasticity related to the fiber cross-sectional area	longitudinal	[MPa]	247.000	-
		transversal		247.000	-
$\varepsilon_{nm,uk}$	Characteristic elongation at failure under tensile load of the non-metallic reinforcement	longitudinal	[‰]	12,6	-
		transversal		12,6	-
f_{bk}	Characteristic short-term bond strength for anchoring for ≥ C30/37	longitudinal	[MPa]	1,7	-
		transversal		1,7	-
$\tau_{bm,k}$	Characteristic value of the mean bond stress (k_t=0) for ≥ C30/37	longitudinal	[MPa]	7,1	-
		transversal		7,1	-
$F_{nm,k}$	Characteristic tensile force transmission of the non-metallic reinforcement per m width	longitudinal	[kN/m]	145	-
		transversal		145	-

Coefficients		Unit	Value	Tolerance
α_{Tt}	Coefficient for considering influences from short-term particularly high temperature stress on the tensile strength [2]	[-]	1,0 at -20°C ≤ T ≤ 70°C 0,95 at 70°C < T ≤ 80°C	-
α_{Tb}	Coefficient for considering influences from short-term particularly high temperature stress on the bond behavior [2]	[-]	1,0 at -20°C ≤ T ≤ 70°C 0,95 at 70°C < T ≤ 80°C	-
α_{nmt}	Coefficient for considering durability influences and long-term stresses on the tensile strength	[-]	0,83	-
α_{nmb}	Coefficient for considering durability influences and long-term stresses on the bond strength	[-]	0,83	-

Characteristic values for anchoring and lapping			Unit	Value	Tolerance
	Applicable reinforcement stress for the anchorage proof	longitudinal	[MPa]	885	-
		transversal		885	-
$l_{b,min}$	Minimum anchoring length	longitudinal	[mm]	42	-
		transversal		42	-
$l_{0,min}$	Minimum lap length	longitudinal	[mm]	63	-
		transversal		63	-
	Minimum lap length for transferring $f_{nm,k}$ in lap joint [3]	longitudinal	[mm]	700	-
		transversal		700	-

Further key values		Unit	Value	Tolerance
$c_{min,b}$	Minimum concrete cover from bond requirement [4]	[mm]	14	-
h_{min}	Minimum component thickness [4]	[mm]	≥ 30	-
n	Proof of robustness for predominantly static loading (number of tested cycles)	[-]	≥ 200.000	-

All values given in accordance with or based on DAfStb guideline "Concrete components with nonmetallic reinforcement", Part 4.

1) Building material class for components from a component thickness of 30 mm with a minimum concrete cover of 14 mm or for components with a component thickness of 30 mm and a single layer of centrally arranged reinforcement grid.

2) To use α_{Tt} = 1 and α_{Tb} = 1: proof required that the temperature loading does not exceed 70°C.

3) For smaller lap lengths, the transferable tensile stresses can be taken from the approval document Table 2, line 10.

4) A component thickness of 30 mm is permissible for components with a single layer of centrally arranged reinforcement grid.

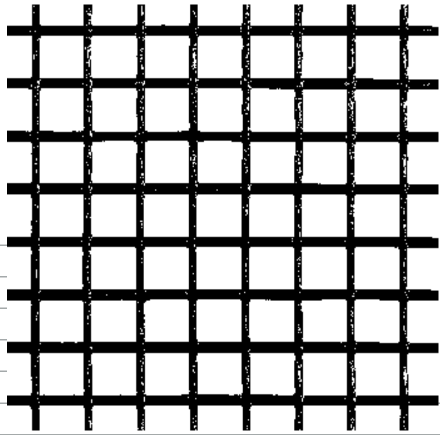
Carbon reinforcement grid solidian GRID for the reinforcement of concrete components with nonmetallic reinforcement	**Appendix 1** **Page 2 of 4**
Grid family 1: **solidian** GRID Q47-C-EP-s38-F145	

Translation of:

National technical approval (abZ)/
General construction technique permit (aBG)

No. Z-1.6-308 dated August 1, 2024 - Translation version: 01 | 09.10.2024

solidian GRID Q85-C-EP-s21-F262



Symmetrical, bidirectional reinforcement grid (type Q) made of media-resistant carbon fiber composite material for the reinforcement of concrete components with predominantly static loads in accordance with German national technical approval/construction technique permit Z-1.6-308

Material		
Fiber material	C (Carbon)	
Impregnating agent	EP (Epoxy resin)	
Color	schwarz	
Surface finish	smooth	
Bending stiffness class	III, stiff	
Validity for concrete strength classes	C30/37 to C70/85	
Chemical resistance of the reinforcement in relation to the exposure classes in accordance with DIN EN 206-1 in conjunction with DIN 1045-2	XD3	Chlorides, except seawater
	XS3	Chlorides from seawater
	XA3	Chemical attack

Geometry and structure			Unit	Value	Tolerance
	Directions of the fiber strands	longitudinal	[°]	0	± 5°
		transversal		90	± 5°
f_h	Mean value of fiber strand width	longitudinal	[mm]	3,4	± 10%
		transversal		4,2	± 10%
f_v	Mean value of fiber strand height	longitudinal	[mm]	1,8	± 10%
		transversal		1,5	± 10%
f_{nm}	Nominal diameter	longitudinal	[mm]	2,37	-
		transversal		2,37	-
A_{nm}	Nominal cross-sectional area per fiber strand	longitudinal	[mm²]	4,4	-
		transversal		4,4	-
a_{nm}	Nominal cross-sectional area per meter	longitudinal	[mm²/m]	210	-
		transversal		210	-
$A_{f,nm}$	Fiber cross-sectional area per fiber strand	longitudinal	[mm²]	1,81	-
		transversal		1,81	-
$a_{f,nm}$	Fiber cross-sectional area per meter	longitudinal	[mm²/m]	85	-
		transversal		85	-
s	Grid width	longitudinal	[mm]	21	± 3 mm
		transversal		21	± 3 mm
s_l	Clear distance of the fiber strands	longitudinal	[mm]	17,0	± 10%
		transversal		18,0	± 10%
h_G	Grid height (average value of the maximum height)		[mm]	2,1	± 10%
g	Weight per unit area of the non-metallic reinforcement		[g/m²]	512	± 10%
$\kappa_ü$	Degree of coverage of the mesh		[%]	32,6	-
r_{min}	Minimum permissible radius of curvature		[mm]	350	-

Material properties			Unit	Value	Tolerance
r	Bulk density of the fiber composite material		[g/cm³]	1,30	-
α	Coefficient of thermal expansion	along the fiber	[10^{-6} 1/K]	0,5	-
T_{g0}	Glass transition temperature (DMA)		[°C]	≥ 110	-
	Recommended operating temperature range		[°C]	-20 bis +80	-
					-
	Building material class reinforcement grid acc. to DIN EN 13501-1		[-]	E, normally flammable	-

Carbon reinforcement grid solidian GRID for the reinforcement of concrete components with nonmetallic reinforcement	**Appendix 1** **Page 3 of 4**
Grid family 1: **solidian** GRID Q85-C-EP-s21-F262	

Mechanical properties			Unit	Value	Tolerance
$f_{nm,k}$	Characteristic short-term tensile strength related to the nominal cross-sectional area	longitudinal	[MPa]	1.250	-
		transversal		1.250	-
E_{nm}	Young's modulus related to the nominal cross-section	longitudinal	[MPa]	99.000	-
		transversal		99.000	-
$f_{f,nm,k}$	Characteristic short-term tensile strength related to the fiber cross-sectional area	longitudinal	[MPa]	3.039	-
		transversal		3.039	-
$E_{f,nm,m}$	Mean modulus of elasticity related to the fiber cross-sectional area	longitudinal	[MPa]	247.000	-
		transversal		247.000	-
$\varepsilon_{nm,uk}$	Characteristic elongation at failure under tensile load of the non-metallic reinforcement	longitudinal	[‰]	12,6	-
		transversal		12,6	-
f_{bk}	Characteristic short-term bond strength for anchoring for ≥ C30/37	longitudinal	[MPa]	1,7	-
		transversal		1,7	-
$\tau_{bm,k}$	Characteristic value of the mean bond stress (k_t=0) for ≥ C30/37	longitudinal	[MPa]	7,1	-
		transversal		7,1	-
$F_{nm,k}$	Characteristic tensile force transmission of the non-metallic reinforcement per m width	longitudinal	[kN/m]	262	-
		transversal		262	-

Coefficients		Unit	Value	Tolerance
α_{Tt}	Coefficient for considering influences from short-term particularly high temperature stress on the tensile strength [2]	[-]	1,0 at -20°C ≤ T ≤ 70°C 0,95 at 70°C < T ≤ 80°C	-
α_{Tb}	Coefficient for considering influences from short-term particularly high temperature stress on the bond behavior [2]	[-]	1,0 at -20°C ≤ T ≤ 70°C 0,95 at 70°C < T ≤ 80°C	-
α_{nmt}	Coefficient for considering durability influences and long-term stresses on the tensile strength	[-]	0,83	-
α_{nmb}	Coefficient for considering durability influences and long-term stresses on the bond strength	[-]	0,83	-

Characteristic values for anchoring and lapping			Unit	Value	Tolerance
	Applicable reinforcement stress for the anchorage proof	longitudinal	[MPa]	885	-
		transversal		885	-
$l_{b,min}$	Minimum anchoring length	longitudinal	[mm]	42	-
		transversal		42	-
$l_{0,min}$	Minimum lap length	longitudinal	[mm]	63	-
		transversal		63	-
	Minimum lap length for transferring $f_{nm,k}$ in lap joint [3]	longitudinal	[mm]	700	-
		transversal		700	-

Further key values		Unit	Value	Tolerance
$c_{min,b}$	Minimum concrete cover from bond requirement [4]	[mm]	14	-
h_{min}	Minimum component thickness [4]	[mm]	≥ 30	-
n	Proof of robustness for predominantly static loading (number of tested cycles)	[-]	≥ 200.000	-

All values given in accordance with or based on DAfStb guideline "Concrete components with nonmetallic reinforcement", Part 4.

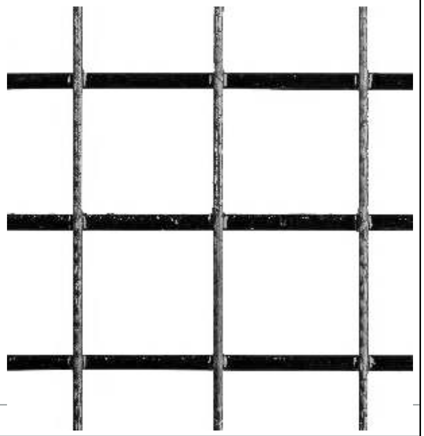
1) Building material class for components from a component thickness of 30 mm with a minimum concrete cover of 14 mm or for components with a component thickness of 30 mm and a single layer of centrally arranged reinforcement grid.
2) To use α_{Tt} = 1 and α_{Tb} = 1: proof required that the temperature loading does not exceed 70°C.
3) For smaller lap lengths, the transferable tensile stresses can be taken from the approval document Table 2, line 10.
4) A component thickness of 30 mm is permissible for components with a single layer of centrally arranged reinforcement grid.

Translation of:

National technical approval (abZ)/
General construction technique permit (aBG)

No. Z-1.6-308 dated August 1, 2024 - Translation version: 01 | 09.10.2024

solidian GRID Q71-C-EP-s51-F207



Symmetrical, bidirectional reinforcement grid (type Q) made of media-resistant carbon fiber composite material for the reinforcement of concrete components with predominantly static loads in accordance with German national technical approval/construction technique permit Z-1.6-308

Material

Fiber material	C (Carbon)	
Impregnating agent	EP (Epoxy resin)	
Color	schwarz	
Surface finish	smooth	
Bending stiffness class	III, stiff	
Validity for concrete strength classes	C30/37 to C70/85	
Chemical resistance of the reinforcement in relation to the exposure classes in accordance with DIN EN 206-1 in conjunction with DIN 1045-2	XD3	Chlorides, except seawater
	XS3	Chlorides from seawater
	XA3	Chemical attack

Geometry and structure

	Geometry and structure		Unit	Value	Tolerance
	Directions of the fiber strands	longitudinal	[°]	0	± 5°
		transversal		90	± 5°
f_h	Mean value of fiber strand width	longitudinal	[mm]	5,0	± 10%
		transversal		5,8	± 10%
f_v	Mean value of fiber strand height	longitudinal	[mm]	2,7	± 10%
		transversal		2,6	± 10%
f_{nm}	Nominal diameter	longitudinal	[mm]	3,35	-
		transversal		3,35	-
A_{nm}	Nominal cross-sectional area per fiber strand	longitudinal	[mm²]	8,8	-
		transversal		8,8	-
a_{nm}	Nominal cross-sectional area per meter	longitudinal	[mm²/m]	173	-
		transversal		173	-
$A_{f,nm}$	Fiber cross-sectional area per fiber strand	longitudinal	[mm²]	3,62	-
		transversal		3,62	-
$a_{f,nm}$	Fiber cross-sectional area per meter	longitudinal	[mm²/m]	71	-
		transversal		71	-
s	Grid width	longitudinal	[mm]	51	± 3 mm
		transversal		51	± 3 mm
s_l	Clear distance of the fiber strands	longitudinal	[mm]	45,4	± 10%
		transversal		46,2	± 10%
h_G	Grid height (average value of the maximum height)		[mm]	3,5	± 10%
g	Weight per unit area of the non-metallic reinforcement		[g/m²]	454	± 10%
$\kappa_ü$	Degree of coverage of the mesh		[%]	20,1	-
r_{min}	Minimum permissible radius of curvature		[mm]	350	-

Material properties

	Material properties		Unit	Value	Tolerance
r	Bulk density of the fiber composite material		[g/cm³]	1,30	-
α	Coefficient of thermal expansion	along the fiber	[10^{-6} 1/K]	0,5	-
T_{g0}	Glass transition temperature (DMA)		[°C]	≥ 110	-
	Recommended operating temperature range		[°C]	-20 bis +80	-
	Building material class reinforcement grid acc. to DIN EN 13501-1		[-]	E, normally flammable	-

Carbon reinforcement grid solidian GRID for the reinforcement of concrete components with nonmetallic reinforcement	**Appendix 2** **Page 1 of 4**
Grid family 2: **solidian** GRID Q71-C-EP-s51-F207	

Mechanical properties			Unit	Value	Tolerance
$f_{nm,k}$	Characteristic short-term tensile strength related to the nominal cross-sectional area	longitudinal	[MPa]	1.200	-
		transversal		1.200	-
E_{nm}	Young's modulus related to the nominal cross-section	longitudinal	[MPa]	97.000	-
		transversal		97.000	-
$f_{f,nm,k}$	Characteristic short-term tensile strength related to the fiber cross-sectional area	longitudinal	[MPa]	2.917	-
		transversal		2.917	-
$E_{f,nm,m}$	Mean modulus of elasticity related to the fiber cross-sectional area	longitudinal	[MPa]	243.000	-
		transversal		243.000	-
$\varepsilon_{nm,uk}$	Characteristic elongation at failure under tensile load of the non-metallic reinforcement	longitudinal	[‰]	12,4	-
		transversal		12,4	-
f_{bk}	Characteristic short-term bond strength for anchoring for ≥ C30/37	longitudinal	[MPa]	2,9	-
		transversal		2,9	-
$\tau_{bm,k}$	Characteristic value of the mean bond stress (k_t=0) for ≥ C30/37	longitudinal	[MPa]	5,9	-
		transversal		5,9	-
$F_{nm,k}$	Characteristic tensile force transmission of the non-metallic reinforcement per m width	longitudinal	[kN/m]	207	-
		transversal		207	-

Coefficients		Unit	Value	Tolerance
α_{Tt}	Coefficient for considering influences from short-term particularly high temperature stress on the tensile strength [2]	[-]	1,0 at -20°C ≤ T ≤ 70°C 0,9 at 70°C < T ≤ 80°C	-
α_{Tb}	Coefficient for considering influences from short-term particularly high temperature stress on the bond behavior [2]	[-]	1,0 at -20°C ≤ T ≤ 70°C 0,9 at 70°C < T ≤ 80°C	-
α_{nmt}	Coefficient for considering durability influences and long-term stresses on the tensile strength	[-]	0,83	-
α_{nmb}	Coefficient for considering durability influences and long-term stresses on the bond strength	[-]	0,83	-

Characteristic values for anchoring and lapping			Unit	Value	Tolerance
	Applicable reinforcement stress for the anchorage proof	longitudinal	[MPa]	1.020	-
		transversal		1.020	-
$l_{b,min}$	Minimum anchoring length	longitudinal	[mm]	76	-
		transversal		76	-
$l_{0,min}$	Minimum lap length	longitudinal	[mm]	117	-
		transversal		117	-
	Minimum lap length for transferring $f_{nm,k}$ in lap joint [3]	longitudinal	[mm]	500	-
		transversal		500	-

Further key values		Unit	Value	Tolerance
$c_{min,b}$	Minimum concrete cover from bond requirement [4]	[mm]	14	-
h_{min}	Minimum component thickness [4]	[mm]	≥ 30	-
n	Proof of robustness for predominantly static loading (number of tested cycles)	[-]	≥ 200.000	-

All values given in accordance with or based on DAfStb guideline "Concrete components with nonmetallic reinforcement", Part 4.

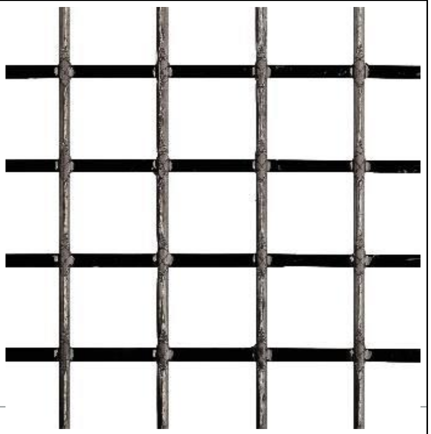
[1] Building material class for components from a component thickness of 30 mm with a minimum concrete cover of 14 mm or for components with a component thickness of 30 mm and a single layer of centrally arranged reinforcement grid.
[2] To use α_{Tt} = 1 and α_{Tb} = 1: proof required that the temperature loading does not exceed 70°C.
[3] For smaller lap lengths, the transferable tensile stresses can be taken from the approval document Table 2, line 10.
[4] A component thickness of 30 mm is permissible for components with a single layer of centrally arranged reinforcement grid.

Translation of:

National technical approval (abZ)/
General construction technique permit (aBG)

No. Z-1.6-308 dated August 1, 2024 - Translation version: 01 | 09.10.2024

solidian GRID Q95-C-EP-s38-F278



Symmetrical, bidirectional reinforcement grid (type Q) made of media-resistant carbon fiber composite material for the reinforcement of concrete components with predominantly static loads in accordance with German national technical approval/construction technique permit Z-1.6-308

Material

Fiber material	C (Carbon)	
Impregnating agent	EP (Epoxy resin)	
Color	schwarz	
Surface finish	smooth	
Bending stiffness class	III, stiff	
Validity for concrete strength classes	C30/37 to C70/85	
Chemical resistance of the reinforcement in relation to the exposure classes in accordance with DIN EN 206-1 in conjunction with DIN 1045-2	XD3	Chlorides, except seawater
	XS3	Chlorides from seawater
	XA3	Chemical attack

Geometry and structure

			Unit	Value	Tolerance
	Directions of the fiber strands	longitudinal	[°]	0	± 5°
		transversal		90	± 5°
f_h	Mean value of fiber strand width	longitudinal	[mm]	4,8	± 10%
		transversal		5,5	± 10%
f_v	Mean value of fiber strand height	longitudinal	[mm]	2,6	± 10%
		transversal		2,5	± 10%
f_{nm}	Nominal diameter	longitudinal	[mm]	3,35	-
		transversal		3,35	-
A_{nm}	Nominal cross-sectional area per fiber strand	longitudinal	[mm²]	8,8	-
		transversal		8,8	-
a_{nm}	Nominal cross-sectional area per meter	longitudinal	[mm²/m]	232	-
		transversal		232	-
$A_{f,nm}$	Fiber cross-sectional area per fiber strand	longitudinal	[mm²]	3,62	-
		transversal		3,62	-
$a_{f,nm}$	Fiber cross-sectional area per meter	longitudinal	[mm²/m]	95	-
		transversal		95	-
s	Grid width	longitudinal	[mm]	38	± 3 mm
		transversal		38	± 3 mm
s_l	Clear distance of the fiber strands	longitudinal	[mm]	32,8	± 10%
		transversal		33,5	± 10%
h_G	Grid height (average value of the maximum height)		[mm]	3,5	± 10%
g	Weight per unit area of the non-metallic reinforcement		[g/m²]	559	± 10%
$\kappa_ü$	Degree of coverage of the mesh		[%]	25,2	-
r_{min}	Minimum permissible radius of curvature		[mm]	350	-

Material properties

			Unit	Value	Tolerance
r	Bulk density of the fiber composite material		[g/cm³]	1,30	-
α	Coefficient of thermal expansion	along the fiber	[10^{-6} 1/K]	0,5	-
T_{g0}	Glass transition temperature (DMA)		[°C]	≥ 110	-
	Recommended operating temperature range		[°C]	-20 bis +80	-
	Building material class reinforcement grid acc. to DIN EN 13501-1		[-]	E, normally flammable	-

Carbon reinforcement grid solidian GRID for the reinforcement of concrete components with nonmetallic reinforcement	**Appendix 2** **Page 3 of 4**
Grid family 2: **solidian GRID** Q95-C-EP-s38-F278	

Mechanical properties			Unit	Value	Tolerance
$f_{nm,k}$	Characteristic short-term tensile strength related to the nominal cross-sectional area	longitudinal	[MPa]	1.200	-
		transversal		1.200	-
E_{nm}	Young's modulus related to the nominal cross-section	longitudinal	[MPa]	97.000	-
		transversal		97.000	-
$f_{f,nm,k}$	Characteristic short-term tensile strength related to the fiber cross-sectional area	longitudinal	[MPa]	2.917	-
		transversal		2.917	-
$E_{f,nm,m}$	Mean modulus of elasticity related to the fiber cross-sectional area	longitudinal	[MPa]	243.000	-
		transversal		243.000	-
$\varepsilon_{nm,uk}$	Characteristic elongation at failure under tensile load of the non-metallic reinforcement	longitudinal	[‰]	12,4	-
		transversal		12,4	-
f_{bk}	Characteristic short-term bond strength for anchoring for ≥ C30/37	longitudinal	[MPa]	2,9	-
		transversal		2,9	-
$\tau_{bm,k}$	Characteristic value of the mean bond stress (k_t=0) for ≥ C30/37	longitudinal	[MPa]	5,9	-
		transversal		5,9	-
$F_{nm,k}$	Characteristic tensile force transmission of the non-metallic reinforcement per m width	longitudinal	[kN/m]	278	-
		transversal		278	-

Coefficients		Unit	Value	Tolerance
α_{Tt}	Coefficient for considering influences from short-term particularly high temperature stress on the tensile strength [2]	[-]	1,0 at -20°C ≤ T ≤ 70°C 0,9 at 70°C < T ≤ 80°C	-
α_{Tb}	Coefficient for considering influences from short-term particularly high temperature stress on the bond behavior [2]	[-]	1,0 at -20°C ≤ T ≤ 70°C 0,9 at 70°C < T ≤ 80°C	-
α_{nmt}	Coefficient for considering durability influences and long-term stresses on the tensile strength	[-]	0,83	-
α_{nmb}	Coefficient for considering durability influences and long-term stresses on the bond strength	[-]	0,83	-

Characteristic values for anchoring and lapping			Unit	Value	Tolerance
	Applicable reinforcement stress for the anchorage proof	longitudinal	[MPa]	1.020	-
		transversal		1.020	-
$l_{b,min}$	Minimum anchoring length	longitudinal	[mm]	76	-
		transversal		76	-
$l_{0,min}$	Minimum lap length	longitudinal	[mm]	117	-
		transversal		117	-
	Minimum lap length for transferring $f_{nm,k}$ in lap joint [3]	longitudinal	[mm]	500	-
		transversal		500	-

Further key values		Unit	Value	Tolerance
$c_{min,b}$	Minimum concrete cover from bond requirement [4]	[mm]	14	-
h_{min}	Minimum component thickness [4]	[mm]	≥ 30	-
n	Proof of robustness for predominantly static loading (number of tested cycles)	[-]	≥ 200.000	-

All values given in accordance with or based on DAfStb guideline “Concrete components with nonmetallic reinforcement”, Part 4.

[1] Building material class for components from a component thickness of 30 mm with a minimum concrete cover of 14 mm or for components with a component thickness of 30 mm and a single layer of centrally arranged reinforcement grid.
[2] To use α_{Tt} = 1 and α_{Tb} = 1: proof required that the temperature loading does not exceed 70°C.
[3] For smaller lap lengths, the transferable tensile stresses can be taken from the approval document Table 2, line 10.
[4] A component thickness of 30 mm is permissible for components with a single layer of centrally arranged reinforcement grid.

Translation of:

National technical approval (abZ)/
General construction technique permit (aBG)

No. Z-1.6-308 dated August 1, 2024 - Translation version: 01 | 09.10.2024

solidian GRID R24/95-C-C-EP-s76/38-F72/278

Symmetrical, bidirectional reinforcement grid (type Q) made of media-resistant carbon fiber composite material for the reinforcement of concrete components with predominantly static loads in accordance with German national technical approval/construction technique permit Z-1.6-308

Material		
Fiber material	C (Carbon)	
Impregnating agent	EP (Epoxy resin)	
Color	schwarz	
Surface finish	smooth	
Bending stiffness class	longitudinal	II, mid
	transversal	III, stiff
Validity for concrete strength classes	C30/37 to C70/85	
Chemical resistance of the reinforcement in relation to the exposure classes in accordance with DIN EN 206-1 in conjunction with DIN 1045-2	XD3	Chlorides, except seawater
	XS3	Chlorides from seawater
	XA3	Chemical attack

Geometry and structure			Unit	Value	Tolerance
	Directions of the fiber strands	longitudinal	[°]	0	± 5°
		transversal		90	± 5°
f_h	Mean value of fiber strand width	longitudinal	[mm]	3,1	± 10%
		transversal		5,5	± 10%
f_v	Mean value of fiber strand height	longitudinal	[mm]	1,8	± 10%
		transversal		3,1	± 10%
f_{nm}	Nominal diameter	longitudinal	[mm]	2,37	-
		transversal		3,35	-
A_{nm}	Nominal cross-sectional area per fiber strand	longitudinal	[mm²]	4,4	-
		transversal		8,8	-
a_{nm}	Nominal cross-sectional area per meter	longitudinal	[mm²/m]	58	-
		transversal		232	-
$A_{f,nm}$	Fiber cross-sectional area per fiber strand	longitudinal	[mm²]	1,81	-
		transversal		3,62	-
$a_{f,nm}$	Fiber cross-sectional area per meter	longitudinal	[mm²/m]	24	-
		transversal		95	-
s	Grid width	longitudinal	[mm]	76	± 3 mm
		transversal		38	± 3 mm
s_l	Clear distance of the fiber strands	longitudinal	[mm]	72,8	± 10%
		transversal		32,5	± 10%
h_G	Grid height (average value of the maximum height)		[mm]	3,0	± 10%
g	Weight per unit area of the non-metallic reinforcement		[g/m²]	381	± 10%
$\kappa_ü$	Degree of coverage of the mesh		[%]	18,0	-
r_{min}	Minimum permissible radius of curvature		[mm]	350	-

Material properties			Unit	Value	Tolerance
r	Bulk density of the fiber composite material		[g/cm³]	1,30	-
α	Coefficient of thermal expansion	along the fiber	[10^{-6} 1/K]	0,5	-
T_{g0}	Glass transition temperature (DMA)		[°C]	≥ 110	-
	Recommended operating temperature range		[°C]	-20 bis +80	-
	Building material class reinforcement grid acc. to DIN EN 13501-1		[-]	E, normally flammable	-

Translation of:

National technical approval (abZ)/
General construction technique permit (aBG)

No. Z-1.6-308 dated August 1, 2024 - Translation version: 01 | 09.10.2024

Mechanical properties			Unit	Value	Tolerance
$f_{nm,k}$	Characteristic short-term tensile strength related to the nominal cross-sectional area	longitudinal	[MPa]	1.250	-
		transversal		1.200	-
E_{nm}	Young's modulus related to the nominal cross-section	longitudinal	[MPa]	99.000	-
		transversal		97.000	-
$f_{f,nm,k}$	Characteristic short-term tensile strength related to the fiber cross-sectional area	longitudinal	[MPa]	3.039	-
		transversal		2.917	-
$E_{f,nm,m}$	Mean modulus of elasticity related to the fiber cross-sectional area	longitudinal	[MPa]	247.000	-
		transversal		243.000	-
$\varepsilon_{nm,uk}$	Characteristic elongation at failure under tensile load of the non-metallic reinforcement	longitudinal	[‰]	12,6	-
		transversal		12,4	-
f_{bk}	Characteristic short-term bond strength for anchoring for ≥ C30/37	longitudinal	[MPa]	1,7	-
		transversal		2,9	-
$\tau_{bm,k}$	Characteristic value of the mean bond stress (k_t=0) for ≥ C30/37	longitudinal	[MPa]	7,1	-
		transversal		5,9	-
$F_{nm,k}$	Characteristic tensile force transmission of the non-metallic reinforcement per m width	longitudinal	[kN/m]	72	-
		transversal		278	-

Coefficients			Unit	Value	Tolerance
α_{Tt}	Coefficient for considering influences from short-term particularly high temperature stress on the tensile strength [2]	longitudinal	[-]	1,0 at -20°C ≤ T ≤ 70°C 0,95 at 70°C < T ≤ 80°C	-
		transversal	[-]	1,0 at -20°C ≤ T ≤ 70°C 0,9 at 70°C < T ≤ 80°C	
α_{Tb}	Coefficient for considering influences from short-term particularly high temperature stress on the bond behavior [2]	longitudinal	[-]	1,0 at -20°C ≤ T ≤ 70°C 0,95 at 70°C < T ≤ 80°C	-
		transversal	[-]	1,0 at -20°C ≤ T ≤ 70°C 0,9 at 70°C < T ≤ 80°C	
α_{nmt}	Coefficient for considering durability influences and long-term stresses on the tensile strength		[-]	0,83	-
α_{nmb}	Coefficient for considering durability influences and long-term stresses on the bond strength		[-]	0,83	-

Characteristic values for anchoring and lapping			Unit	Value	Tolerance
	Applicable reinforcement stress for the anchorage proof	longitudinal	[MPa]	885	-
		transversal		1.020	-
$l_{b,min}$	Minimum anchoring length	longitudinal	[mm]	42	-
		transversal		76	-
$l_{0,min}$	Minimum lap length	longitudinal	[mm]	228	-
		transversal		117	-
	Minimum lap length for transferring $f_{nm,k}$ in lap joint [3]	longitudinal	[mm]	700	-
		transversal		500	-

Further key values		Unit	Value	Tolerance
$c_{min,b}$	Minimum concrete cover from bond requirement [4]	[mm]	14	-
h_{min}	Minimum component thickness [4]	[mm]	≥ 30	-
n	Proof of robustness for predominantly static loading (number of tested cycles)	[-]	≥ 200.000	-

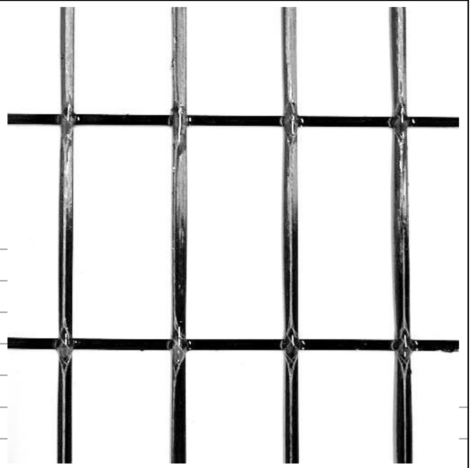
All values given in accordance with or based on DAfStb guideline “Concrete components with nonmetallic reinforcement”, Part 4.

1) Building material class for components from a component thickness of 30 mm with a minimum concrete cover of 14 mm or for components with a component thickness of 30 mm and a single layer of centrally arranged reinforcement grid.
2) To use α_{Tt} = 1 and α_{Tb} = 1: proof required that the temperature loading does not exceed 70°C.
3) For smaller lap lengths, the transferable tensile stresses can be taken from the approval document Table 2, line 10.
4) A component thickness of 30 mm is permissible for components with a single layer of centrally arranged reinforcement grid.

Carbon reinforcement grid solidian GRID for the reinforcement of concrete components with nonmetallic reinforcement	**Appendix 3** **Page 2 of 4**
Grid family 3: **solidian** GRID R24/95-C-C-EP-s76/38-F72/278	

solidian GRID R95/24-C-C-EP-s38/76-F278/72

Symmetrical, bidirectional reinforcement grid (type Q) made of media-resistant carbon fiber composite material for the reinforcement of concrete components with predominantly static loads in accordance with German national technical approval/construction technique permit Z-1.6-308



Material		
Fiber material	C (Carbon)	
Impregnating agent	EP (Epoxy resin)	
Color	schwarz	
Surface finish	smooth	
Bending stiffness class	longitudinal	III, stiff
	transversal	II, mid
Validity for concrete strength classes	C30/37 to C70/85	
Chemical resistance of the reinforcement in relation to the exposure classes in accordance with DIN EN 206-1 in conjunction with DIN 1045-2	XD3	Chlorides, except seawater
	XS3	Chlorides from seawater
	XA3	Chemical attack

Geometry and structure			Unit	Value	Tolerance
	Directions of the fiber strands	longitudinal	[°]	0	± 5°
		transversal		90	± 5°
f_h	Mean value of fiber strand width	longitudinal	[mm]	5,5	± 10%
		transversal		3,8	± 10%
f_v	Mean value of fiber strand height	longitudinal	[mm]	3,1	± 10%
		transversal		1,8	± 10%
f_{nm}	Nominal diameter	longitudinal	[mm]	3,35	-
		transversal		2,37	-
A_{nm}	Nominal cross-sectional area per fiber strand	longitudinal	[mm²]	8,8	-
		transversal		4,4	-
a_{nm}	Nominal cross-sectional area per meter	longitudinal	[mm²/m]	58	-
		transversal		232	-
$A_{f,nm}$	Fiber cross-sectional area per fiber strand	longitudinal	[mm²]	3,62	-
		transversal		1,81	-
$a_{f,nm}$	Fiber cross-sectional area per meter	longitudinal	[mm²/m]	95	-
		transversal		24	-
s	Grid width	longitudinal	[mm]	38	± 3 mm
		transversal		76	± 3 mm
s_l	Clear distance of the fiber strands	longitudinal	[mm]	33,4	± 10%
		transversal		72,8	± 10%
h_G	Grid height (average value of the maximum height)		[mm]	3,3	± 10%
g	Weight per unit area of the non-metallic reinforcement		[g/m²]	350	± 10%
$\kappa_ü$	Degree of coverage of the mesh		[%]	17,4	-
r_{min}	Minimum permissible radius of curvature		[mm]	350	-

Material properties			Unit	Value	Tolerance
r	Bulk density of the fiber composite material		[g/cm³]	1,30	-
α	Coefficient of thermal expansion	along the fiber	[10^{-6} 1/K]	0,5	-
T_{g0}	Glass transition temperature (DMA)		[°C]	≥ 110	-
	Recommended operating temperature range		[°C]	-20 bis +80	-
	Building material class reinforcement grid acc. to DIN EN 13501-1		[-]	E, normally flammable	-

Mechanical properties			Unit	Value	Tolerance
$f_{nm,k}$	Characteristic short-term tensile strength related to the nominal cross-sectional area	longitudinal	[MPa]	1.200	-
		transversal		1.250	-
E_{nm}	Young's modulus related to the nominal cross-section	longitudinal	[MPa]	97.000	-
		transversal		99.000	-
$f_{f,nm,k}$	Characteristic short-term tensile strength related to the fiber cross-sectional area	longitudinal	[MPa]	2.917	-
		transversal		3.039	-
$E_{f,nm,m}$	Mean modulus of elasticity related to the fiber cross-sectional area	longitudinal	[MPa]	243.000	-
		transversal		247.000	-
$\varepsilon_{nm,uk}$	Characteristic elongation at failure under tensile load of the non-metallic reinforcement	longitudinal	[‰]	12,4	-
		transversal		12,6	-
f_{bk}	Characteristic short-term bond strength for anchoring for ≥ C30/37	longitudinal	[MPa]	2,9	-
		transversal		1,7	-
$\tau_{bm,k}$	Characteristic value of the mean bond stress (k_t=0) for ≥ C30/37	longitudinal	[MPa]	5,9	-
		transversal		7,1	-
$F_{nm,k}$	Characteristic tensile force transmission of the non-metallic reinforcement per m width	longitudinal	[kN/m]	278	-
		transversal		72	-

Coefficients			Unit	Value	Tolerance
α_{Tt}	Coefficient for considering influences from short-term particularly high temperature stress on the tensile strength [2]	longitudinal	[-]	1,0 at -20°C ≤ T ≤ 70°C 0,9 at 70°C < T ≤ 80°C	-
		transversal	[-]	1,0 at -20°C ≤ T ≤ 70°C 0,95 at 70°C < T ≤ 80°C	
α_{Tb}	Coefficient for considering influences from short-term particularly high temperature stress on the bond behavior [2]	longitudinal	[-]	1,0 at -20°C ≤ T ≤ 70°C 0,9 at 70°C < T ≤ 80°C	-
		transversal	[-]	1,0 at -20°C ≤ T ≤ 70°C 0,95 at 70°C < T ≤ 80°C	
α_{nmt}	Coefficient for considering durability influences and long-term stresses on the tensile strength		[-]	0,83	-
α_{nmb}	Coefficient for considering durability influences and long-term stresses on the bond strength		[-]	0,83	-

Characteristic values for anchoring and lapping			Unit	Value	Tolerance
	Applicable reinforcement stress for the anchorage proof	longitudinal	[MPa]	1.020	-
		transversal		885	-
$l_{b,min}$	Minimum anchoring length	longitudinal	[mm]	76	-
		transversal		42	-
$l_{0,min}$	Minimum lap length	longitudinal	[mm]	117	-
		transversal		228	-
	Minimum lap length for transferring $f_{nm,k}$ in lap joint [3]	longitudinal	[mm]	500	-
		transversal		700	-

Further key values		Unit	Value	Tolerance
$c_{min,b}$	Minimum concrete cover from bond requirement [4]	[mm]	14	-
h_{min}	Minimum component thickness [4]	[mm]	≥ 30	-
n	Proof of robustness for predominantly static loading (number of tested cycles)	[-]	≥ 200.000	-

All values given in accordance with or based on DAfStb guideline "Concrete components with nonmetallic reinforcement", Part 4.

[1] Building material class for components from a component thickness of 30 mm with a minimum concrete cover of 14 mm or for components with a component thickness of 30 mm and a single layer of centrally arranged reinforcement grid.

[2] To use α_{Tt} = 1 and α_{Tb} = 1: proof required that the temperature loading does not exceed 70°C.

[3] For smaller lap lengths, the transferable tensile stresses can be taken from the approval document Table 2, line 10.

[4] A component thickness of 30 mm is permissible for components with a single layer of centrally arranged reinforcement grid.

Carbon reinforcement grid solidian GRID for the reinforcement of concrete components with nonmetallic reinforcement	**Appendix 3** **Page 4 of 4**
Grid family 3: **solidian** GRID R95/24-C-C-EP-s38/76-F278/72	

Notes on the manufacture and testing of test components when using the casting process

- The dimensions of the test component must be selected so that the stress on the solidian GRID during concreting corresponds to what is to be expected in the real component.
- The concreting conditions (spacing of the spacers, consistency of the concrete, concreting speed, drop height of the concrete, etc.) must correspond to the concreting conditions of the actual component.
- After the concrete has hardened, at least the concrete cover for all layers of the solidian GRID must be determined using non-destructive or destructive testing methods.
- If it is also considered necessary to determine ultimate loads, at least three separate test specimens (preferably cylinders with a diameter of 150 mm and a height of 300 mm) must be produced in addition to the test component, stored under the conditions of the test specimen and tested at the time of the ultimate load determination.
- In this case, the concrete cover can only be determined using destructive testing methods after the ultimate load has been determined.
- The results of the tests must be recorded (e.g. as an appendix to the construction log book)