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# National technical approval / General construction technique permit

**Number:**

**Z-15.1-352**

**Validity**

from: **7 September 2022**

to: **25 February 2026**

**Applicant:**

**Cobiax Deutschland GmbH**
Am Stadtholz 56
33609 Bielefeld
GERMANY

**Subject of decision:**

**"COBIAX CLS" – a voided slab system**

The subject named above is herewith granted a national technical approval (*allgemeine bauaufsichtliche Zulassung*) / general construction technique permit (*allgemeine Bauartgenehmigung*).

This decision contains 17 pages and three annexes with ten pages.

This national technical approval / general construction technique permit replaces national technical approval / general construction technique permit no. 15.1-352 of 25 February 2021.

The subject concerned was granted the first national technical approval on 25 February 2021.

**Translation authorised by DIBt**

# I GENERAL PROVISIONS

1 This decision confirms the fitness for use and application of the subject concerned within the meaning of the Building Codes of the federal states (*Landesbauordnungen*).

2 This decision does not replace the permits, approvals and certificates required by law for carrying out construction projects.

3 This decision is granted without prejudice to the rights of third parties, in particular private property rights.

4 Notwithstanding further provisions in the 'Special Provisions', copies of this decision shall be made available to the user and installer of the subject concerned. The user and installer of the subject concerned shall also be made aware that this decision must be made available at the place of use or place of application. Upon request, copies of the decision shall be provided to the authorities involved.

5 This decision shall be reproduced in full only. Partial publication requires the consent of DIBt. Texts and drawings in promotional material shall not contradict this decision. In the event of a discrepancy between the German original and this authorised translation, the German version shall prevail.

6 This decision may be revoked. The provisions contained herein may subsequently be supplemented and amended, in particular if this is required by new technical findings.

7 This decision is based on the information and documents provided by the applicant. Alterations to this basis are not covered by this decision and shall be notified to DIBt without delay.

# II SPECIAL PROVISIONS

## 1 Subject concerned and field of use and application

### 1.1 Subject of approval and field of use

The subject of approval are the installation elements, i.e. the "structural formers", of the "COBIAX CLS" voided slab system. These shall correspond to Annex 1.

The structural formers are used as an internal permanent formwork and create voided areas within reinforced concrete slabs.

### 1.2 Subject of permit and field of application

The subject of the permit are the provisions for the planning, design and execution of plane, non-inclined reinforced concrete floors as slabs with voided areas, which are produced by the installation of COBIAX CLS installation elements (voided slabs).

The voided slabs with COBIAX CLS installation elements are made using normal weight concrete of strength classes C20/25 to C45/55 in accordance with DIN EN 206-1:2001-07/A1:2004/A2:2005 in conjunction with DIN 1045-2:2008-08. They shall be subjected only to predominantly static actions in accordance with DIN EN 1992-1-1:2011-01 in conjunction with DIN EN 1992-1-1/NA:2013-04; Section NA 1.5.2.6.

The characteristic area load capacity of the voided slabs shall not exceed 10 kN/m$^2$.

The structural formers shall solely be arranged in an orthogonal grid in the main span directions of the voided slab and shall be installed in a single layer only.

Planned tensile or compressive loads shall not be introduced into the structural former areas of the voided slabs.

Prestressing of the structural former area is not regulated in this decision.

If fire resistance is required, the voided slabs with COBIAX CLS installation elements may be used in accordance with the provisions in Section 3.2.9.

## 2 Provisions for the construction product

### 2.1 Properties and composition

COBIAX CLS installation elements shall be made of PE-HD or PP in accordance with the data sheet deposited with DIBt. Dimensions and relevant data are given in Annex 1 and the deposited documents.

### 2.2 Manufacture, packaging, transport, storage and marking

#### 2.2.1 Manufacture

For the manufacture of the COBIAX CLS installation elements, the requirements specified in Section 2.3, Annex 1 and the deposited documents shall be complied with.

#### 2.2.2 Packaging, transport, storage

It shall be ensured that no damage to the COBIAX CLS installation elements can occur during transport and storage.

#### 2.2.3 Marking

The manufacturer shall affix the national conformity mark (*Ü-Zeichen*) to the COBIAX CLS installation elements in accordance with the Conformity Marking Ordinances (*Übereinstimmungszeichen-Verordnungen*) of the federal states. The mark shall only be applied if the requirements given in Section 2.3 are met.

The COBIAX CLS installation elements shall be marked prior to delivery such that they cannot be confused during installation.

The top side of the COBIAX CLS installation element shall be marked permanently and legibly showing the type and height of the structural former.

## 2.3 Confirmation of conformity

### 2.3.1 General

The manufacturer shall confirm for each manufacturing plant that the COBIAX CLS installation element complies with the provisions of the national technical approval included in this decision by way of a declaration of conformity based on factory production control and a certificate of conformity issued by a certification body recognised for these purposes as well as on regular external surveillance including initial type-testing of the COBIAX CLS installation element carried out by a recognised inspection body in accordance with the following provisions.

To issue the certificate of conformity and for external surveillance, including the associated product testing, the manufacturer of the COBIAX CLS installation element shall use a certification body and an inspection body recognised for these purposes.

The declaration of conformity shall be submitted by the manufacturer through marking of the construction products with the national conformity mark (*Ü-Zeichen*) including statement of the intended use.

The certification body shall send a copy of the certificate of conformity issued by it, as well as a copy of the initial type-testing evaluation report to DIBt.

Installation instructions shall be provided with each delivery.

### 2.3.2 Factory production control

A factory production control system shall be set up and implemented in each manufacturing plant. Factory production control shall be understood to be continuous surveillance of production by the manufacturer to ensure that the manufactured COBIAX CLS installation elements satisfy the provisions of the national technical approval included in this decision.

The factory production control shall at least include the measures listed in the control plan deposited with DIBt.

The results of factory production control shall be recorded and evaluated. The records shall at least include the following information:

- designation of the COBIAX CLS installation element including the starting materials and the components
- type of check or test
- date of manufacture and testing of the COBIAX CLS installation element or the starting material or the components
- result of the checks or tests and comparison with the requirements
- signature of the person responsible for factory production control.

The records shall be kept for at least five years and submitted to the inspection body used for external surveillance. They shall be submitted to DIBt and the competent supreme building authority upon request.

If the test result is unsatisfactory, the manufacturer shall immediately take the necessary measures to resolve the defect. Construction products which do not meet the requirements shall be handled in such a way that they cannot be confused with compliant products. After the defect has been remedied, the relevant test shall be repeated immediately – where technically feasible and necessary to show that the defect has been eliminated.

### 2.3.3 External surveillance

In each manufacturing plant, factory production control shall be checked regularly at least twice a year by means of external surveillance. In that process, the COBIAX CLS installation elements and components given in Annex 1 shall be tested as specified in the deposited documents.

Within the scope of external surveillance, initial type-testing of the COBIAX CLS installation elements given in Annex 1 shall be carried out. Samples for the tests specified in the deposited documents shall be taken and then tested. Sampling and testing shall be the responsibility of the recognised inspection body.

The results of certification and external surveillance shall be kept for at least five years. They shall be submitted by the certification or inspection body to DIBt and the competent supreme building authority upon request.

## 3 Provisions for planning, design and execution

### 3.1 Planning

### 3.1.1 General

The conditions of application specified in Section 1.2 of this decision shall be adhered to.

For point loads, the information in Section 3.2.4 of this decision shall be observed.

For slab thicknesses of h > 500 mm, the maximum characteristic value of line loads in the area of the structural formers shall not exceed 30 kN per running meter.

The structural formers shall solely be arranged in an orthogonal grid in the main span directions of the voided slab. They shall be installed across the entire area of the slab on a uniform height level. The structural formers shall be installed without offset between the structural formers, see Section 3.3.3 of this decision as well as Annex 3.

The structural formers shall be installed only in flat slab areas where the requirements for the definition as a slab in accordance with DIN EN 1992-1-1 in conjunction with DIN EN 1992-1-1/NA, NA 1.5.2.20 are met.

The flexural tension and flexural compression reinforcement (longitudinal) shall always be arranged in the main and secondary load-carrying direction. Any deviation from this may only occur in small areas if the corresponding detailing is taken into account/executed.

The diameter of the reinforcing bars in the areas of the structural formers shall as a rule not exceed 16 mm. For distances from the void former surface (without the spacer strips) to the upper/lower edge of the slab ≥ 80 mm, reinforcing bars with a diameter of 20 mm may also be installed.

For the two lower reinforcement layers in the structural former area, the minimum bar spacing shall be 75 mm. Pairs of bars shall not be arranged there.

When determining the properties of the concrete resp. of the fresh concrete, the geometry of the structural formers and the bar spacing of the reinforcing bars (between each other and towards the structural formers) shall be taken into account. Corresponding information (such as the consistency of the fresh concrete and the maximum grain size of the aggregate) shall be included in the general arrangement and reinforcement plans, see also Section 3.3.3 of this decision.

The provisions for execution in accordance with Section 3.3 of this decision as well as the installation instructions (Annex 3) shall be taken into account during planning. For this, the corresponding representations shall be included in the layout drawings.

In the case of concreting in two passes (two concreting layers with interruption in between), the type of placement of the lower or first concrete layer shall be clearly shown in the layout drawings. If the lower layer is also concreted outside the areas of the structural formers, the connecting reinforcement that may then be required in the solid area shall be shown in the

layout drawings. If the lower concrete layer is placed at the edge of the structural former area or at the transition to the solid area of the slab, appropriate information shall be included in the layout drawings.

The fact that the COBIAX CLS installation elements can float upwards during concreting shall also be taken into account during planning. In every application, the structural formers shall therefore be fixed in position by suitable measures and secured against uplift or displacement to the side. These securing measures shall be determined during planning and included in the layout drawings. Furthermore, the tolerances yielded from this and any planned interruptions during the concreting process shall be taken into account during planning.

The application is limited to normal strength concrete of strength classes C20/25 to C45/55 in accordance with DIN EN 206-1 in conjunction with DIN 1045-2. Ribbed reinforcing steel B500A or B500B in accordance with DIN 488-1 or a national technical approval shall be installed as reinforcement.

### 3.1.2 Dimensions

During cross-sectional planning, the concrete covers for the reinforcement (also in the direction towards the structural formers), the required height for the crossing reinforcement layers and the cross-sectional height for the installation element as well as the requirements in accordance with Sections 3.1.8 and 3.2.9 shall be taken into account. The anchorage and overlapping areas of the reinforcement shall be considered in particular.

The minimum thicknesses of the voided slab shall be specified in accordance with DIN EN 1992-1-1 in conjunction with DIN EN 1992-1-1/NA in consideration of the provisions of this decision. However, the minimum thickness of the voided slab and the distance from the void former surface (without the spacer strip) to the upper/lower edge of the slab shall not be less than the values specified in Annex 1. During cross-sectional planning, for each slab thickness $h$, the minimum distance from the void former surface (without the spacer strip) to the upper/lower edge of the slab corresponding to the largest possible structural former type that can be used in the respective slab cross-section shall be maintained.

When determining the minimum thicknesses of the voided slabs the fire safety requirements specified in Section 3.2.9.2 shall also be observed.

The maximum slab thickness shall be 760 mm. If slab thicknesses h > 760 mm up to a maximum of 800 mm are planned, they shall be assigned a shear resistance $V_{Rd,c,cobiax}$ in accordance with Section 3.2.3, Equation (1) of a 760 mm thick voided slab with 580 mm or 590 mm high structural formers. This means that the effective depth $d$ for the verification of the shear resistance is in these cases determined and applied in substitution for a reduced slab thickness $h$ = 760 mm only. For the design, the self-weight of the voided slab resulting from the actual height shall be taken into account.
The flexural tension and flexural compression reinforcement shall be arranged in the main and secondary load-carrying direction.

At no point shall the net concrete cross-sectional area (vertical section with respect to the horizontal slab plane) be less than 42% of the total cross-sectional area.

### 3.1.3 Supports

No structural formers shall be positioned above the supports of the voided slab to be created. The size of the areas with solid cross-sections as solid slabs shall be defined by the shear force and punching shear verifications (see Sections 3.2.3 and 3.2.4).

A parallel solid strip with a width of at least the slab thickness $h$ (but not less than 350 mm) shall be provided along a support (to the side of the support edge).

### 3.1.4 Concrete cover

The concrete cover of the reinforcing steel to the member surfaces shall be maintained in accordance with the provisions of Section 4.4.1 of DIN EN 1992-1-1 in conjunction with DIN EN 1992-1-1/NA. The allowance/deviation for the concrete cover shall be increased by the actually possible displacement of the COBIAX CLS installation elements (e.g. due to uplift) and stated on the reinforcement drawings if the value of $\Delta c_{dev}$ in accordance with DIN EN 1992-1-1 and DIN EN 1992-1-1/NA, Section 4.4.1.3 is exceeded by this displacement.

When using Cobiax CLS installation elements in voided slabs in all exposure classes XD or XS, a properly maintained, crack-bridging surface protection system (two-dimensional or as crack bandages with maintenance plan) or a sealant in accordance with the valid version of DIN 18531 or DIN 18532 shall be provided so that no water containing chloride can penetrate into the voided slab via cracks, construction joints or defects.
The following shall apply to the concrete cover of the reinforcing steel towards the surface of the structural former:

1) The minimum concrete cover from the exposure class requirement XC1 ($c_{min,dur}$ = 10 mm) and from the bond requirement ($c_{min,b}$ = bar diameter) shall be taken into account in accordance with DIN EN 1992-1-1 and DIN EN 1992-1-1/NA. The greater of the two values shall be decisive for the minimum concrete cover in the direction of the structural former surface (without spacer strips) and be maintained.
2) The allowance/deviation for the concrete cover in the direction of the structural former surface (without the spacer strips) $\Delta c_{dev}$ shall be ≥ 10 mm. This value shall be taken into account in the planning resp. cross-sectional planning of the voided slab.
3) Due to the arrangement of the ribs or spacer strips (rib height = 10 mm resp. 15 mm), which are firmly connected to the structural formers and serve as spacers, the allowance of the concrete cover to the structural former surface (without the spacer strips) may be reduced: 10 mm ≥ $\Delta c_{dev}$ ≥ 0 mm, if the following conditions a), b) and c) are maintained:
   a) Adequate stiffness of the crossing reinforcement layers shall be ensured. Stiffness may be considered adequate if in both reinforcement directions (longitudinal and transverse reinforcement) the bar spacing is ≤ 150 mm and the bar diameter Ø ≥ 10 mm (or the bar spacing is ≤ 200 mm and Ø ≥ 12 mm).
   b) The bar diameter Ø of the reinforcement direction which is installed with direct contact to the ribs (spacer strips) of the structural formers shall be exclusively Ø = 10 mm for the structural formers with rib height = 10 mm resp.

      10 mm ≤ Ø ≤ 14 mm for the structural formers with rib height = 15 mm.
   c) For the lower crossing reinforcement layers of the voided slab (area below the structural formers), in addition to the above conditions a) and b), the requirement shall be met that the minimum clearance distance between the reinforcement bars and the structural former underside (without the spacer strips) is ≥ 15 mm so that the reinforcing steels can be tightly encased in concrete in a proper way. This means that the installation of load-bearing or structurally required reinforcement bars having direct contact to the ribs (spacer strips) of the structural formers in this area are permitted only for a rib height = 15 mm.
4) If additional spacers (e.g. trestles and/or reinforcing steel placed on the spacer bars) are used to maintain the concrete covers to the surface of the structural formers, a reduction in the allowance of the concrete cover to the surface of the structural formers is not permitted.

DBV data sheets "Supports" and "Spacers" shall be taken into account for the spacers. Corresponding representations shall be included in the layout and reinforcement drawings, see Annex 3, Fig. 5.

For determining the required concrete cover and the reinforcing construction, anchorage and overlapping areas of the reinforcement shall be given particular consideration.

### 3.1.5 Edge distances

The required edge distances of the COBIAX CLS installation elements in the direction of all other members, installation elements etc. shall be taken into account in the execution planning as well as in the execution.

### 3.1.6 Suspended loads in the area of the structural formers

Planned suspended loads in the area of the void former surface and the lower edge of the slab shall be sufficiently anchored. For the verification, only the actually existing concrete cross-section may be applied. If necessary, a sufficiently large area shall be provided as a solid cross-section by omitting individual structural formers.

### 3.1.7 Recesses and slab edges

Recesses shall be verified separately in accordance with Section 3.2.8 of this decision. Recesses and free slab edges shall be enclosed by solid areas with a width of slab thickness *h*, but not exceeding 450 mm. Recesses and free slab edges shall be enclosed by longitudinal and transverse reinforcements in accordance with DIN EN 1992-1-1 and DIN EN 1992-1-1/NA, 9.3.1.4.

### 3.1.8 Conduits

Empty conduits shall not be routed in the areas of the structural formers including their web areas if the external diameter of the conduits is ø > 25 mm. Additional solid areas with solid cross-sections shall be formed for such conduits.

With a minimum distance of 1.20 m for empty conduits with an outer diameter ø ≤ 25 mm, one empty conduit each may be arranged in both directions at the height of the connecting webs. At this level, these conduits may also cross each other. In the area between the connections, the conduits shall be secured against buoyancy.

If conduits with a small external diameter (ø ≤ 25 mm) are installed in the area between the void former surface and the upper/lower edge of the slab, the thickness of such area and thus the slab thickness *h* shall be increased by at least 25 mm. This increase in the slab thickness shall not be taken into account when determining the effective depth *d* for verifying the shear resistance in accordance with Section 3.2.3, equation (1). The spacing of the conduits to each other in this area shall not be less than 175 mm (or not less than 150 mm for conduits with ø ≤ 20 mm).

Conduit crossings in the area between the void former surface and the upper/lower edge of the slab are not permitted. If conduit crossings or penetrations to the more distant slab surface are required, solid areas without structural formers shall be formed.

## 3.2 Design

### 3.2.1 General

Unless otherwise specified below, DIN EN 1992-1-1 in conjunction with DIN EN 1992-1-1/NA shall apply to the design.

The reduced bending stiffness in the areas of the structural formers shall be considered when the internal forces of the voided slab are determined. Solid slab strips between the areas with structural formers shall be separately taken into account because they can cause higher internal forces and moments due to the greater stiffnesses.

In addition, the reduced concrete cross-section and the weight reduction in the areas of the structural formers shall be taken into account.

Planned tensile or compressive loads shall not be introduced into the structural former areas of the voided slabs.

For determining the internal forces and moments, methods based on the plasticity theory and nonlinear methods shall not be applied.

As an approximation, it can be assumed that the torsional stiffness of the voided slab in comparison with the torsional stiffness of a solid slab is reduced in the same ratio as the flexural rigidity provided that the specifications contained in this decision are complied with.

### 3.2.2 Bending

DIN EN 1992-1-1 and DIN EN 1992-1-1/NA, Clause 6.1, shall apply. The concrete cross-section shall be mathematically reduced by the largest void cross-section in the relevant section. The concrete pressure zone shall be reduced by the cross-section of any conduits located in the pressure zone.

It shall be verified that the concrete pressure zone height determined in the ultimate limit state is not greater than the concrete cover above - in the case of negative moments below - the 10 mm or 15 mm high integrated ribs or spacer strips of the structural formers. In the verification, the concrete cover shall be reduced mathematically by an allowance of 5 mm to allow for an unwanted displacement of the structural formers towards the member surface.

The net concrete cross-section $A_{c,net}$ minus the structural formers shall be at least 42 % of the overall cross-sectional area $A_c$.

The transfer of transverse tensile stresses arising due to an explosive effect in the concrete in the anchoring and overlapping area of the reinforcement shall also be ensured in the structural former area in accordance with DIN EN 1992-1-1 in conjunction with DIN EN 1992-1-1/NA. The transverse reinforcement required for this shall be positioned between the longitudinal reinforcement and the concrete surface - also towards the structural former surface.

### 3.2.3 Verification of shear resistance

DIN EN 1992-1-1 and DIN EN 1992-1-1/NA, Clause 6.2.2, shall apply. However, equation (6.2.a) shall be replaced as follows:

$$V_{\mathrm{Rd,c,cobiax}} = f \cdot \left[\frac{0.15}{\gamma_{\mathrm{C}}}\ \kappa\ \ (100\ \rho_1\ f_{\mathrm{ck}})^{1/3}\right]\ b\ d \qquad \text{Equation (1)}$$

Where:

$V_{\mathrm{Rd,c,cobiax}}$: design shear resistance of the COBIAX CLS slab without shear reinforcement

$f$ the reduction factor to take into account the reduced shear resistance as a result of the voids:

- $f$ = 0.45 for slab thickness $h$ = 200 mm,
- $f$ = 0.40 for slab thicknesses $h \geq 480$ mm

Intermediate values may be interpolated.

At end supports (supports of single span slabs or end supports of continuous slabs), the reduction factor $f$ for high slab cross-sections shall be reduced linearly from $f$ = 0.40 for a slab thickness $h$ = 480 mm to $f$ = 0.35 for a slab thickness $h$ = 760 mm;

$\gamma_C$ partial safety factor for reinforced concrete in accordance with DIN EN 1992-1-1 and DIN EN 1992-1-1/NA, Clause 2.4.2.4, Table 2.1 DE

$\kappa$ scale factor where $\kappa = 1 + \sqrt{\frac{200}{d}} \leq 2.0$

$\rho_l$ longitudinal reinforcement ratio where $\rho_l = A_{sl} / (b\ d) \leq 0.02$

$A_{sl}$ area of actually existing tensile reinforcement in the respective direction of support, which extends at least by the dimension d past the considered cross-section and is effectively anchored there (see DIN EN 1992-1-1 and DIN EN 1992-1-1/NA, Figure 6.3).

For a deviating arrangement of COBIAX CLS installation elements from the main load-bearing direction in smaller areas, such as oriels and interior corners, the resulting longitudinal reinforcement ratio may be assumed.

$b$ cross-section width

*d* effective depth of the flexural reinforcement in the considered cross-section in mm. Here, Sections 3.1.2, and 3.1.8 shall be observed.

Equations (6.2.b) and (6.4) of DIN EN 1992-1-1 with DIN EN 1992-1-1/NA shall not be used in the verification.

In addition, a minimum shear force reinforcement shall be installed in the void area of the voided slab, which at the same time acts as minimum connecting reinforcement and robustness reinforcement for the slab structure.

The reinforcement elements of the minimum shear force reinforcement shall, with respect to their bending shape, be designed as shear reinforcement assemblies in accordance with DIN EN 1992-1-1 and DIN EN 1992-1-1/NA Clauses 9.2.2 and 9.3.2.

As a minimum shear force reinforcement, 4 shear reinforcement assemblies, diameter ≥ 8 mm (4 Ø 8), shall be installed in each intermediate area (X zone) of the structural formers. For a definition of the X zone, please refer to the illustrations in Annex 1, Figure 1 and Figure 2 as well as Annex 3, Figure 4. The shear reinforcement assemblies shall, in accordance with DIN EN 1992-1-1 and DIN EN 1992-1-1/NA Clause 9.2.2 and taking into account the concrete cover, be implemented across the entire cross-sectional height of the voided slab and sufficiently anchored in the compression and tension zone.

For the arrangement of the shear reinforcement assemblies in the X zone of the structural formers resp. in the ground plan of the slab, the information provided in Annex 3, Figure 4 shall be observed.

This minimum shear force reinforcement shall be installed in any case, even if no connecting reinforcement is mathematically required (even if concreting is carried out without an intermediate interruption and no bond proof is required).

The minimum shear force reinforcement or connecting reinforcement shall mathematically not be taken into account for the shear resistance of the COBIAX CLS slab.

Planned tensile forces shall not be introduced into the structural former areas of the voided slabs.

Furthermore, verification of the shear resistance of the voided slabs shall be carried out applying the main shear force and the degree of reinforcement in orthogonal direction.
Vectorially splitting the shear force into the principal stress directions for easier or more favourable verification may increase model uncertainties and shall therefore not be used.
It shall be verified that the ribs or spacer strips of the structural formers do not extend into the concrete pressure zone height determined in the ultimate limit state. The decisive concrete pressure zone height shall be determined in the section that is decisive for the bending design, see also Section 3.2.2 of this decision.
Structural former areas requiring design shear reinforcement are not covered by this decision.

Slab areas in which the design value of the shear resistance of the Cobiax CLS slab $V_{Rd,c,cobiax}$ in accordance with equation (1) is exceeded shall be verified, designed and executed as solid areas with solid cross-sections without structural formers.

A transition within a slab field of void areas to adjoining areas designed and dimensioned as ribbed or coffered slabs is not permitted.

### 3.2.4 Punching shear and point loads

In the structural former area, the characteristic value of the point loads shall not exceed 10 kN at a minimum contact area of 100 mm x 100 mm. Affected tension zones of the voided slab shall be reinforced.

For columns, point loads and reactions acting on a relatively small area exceeding 10 kN, DIN EN 1992-1-1 in conjunction with DIN EN 1992-1-1/NA, Clause 6.4, shall apply.

The punching shear areas shall be formed as solid areas with solid cross-sections without structural formers. The size of the solid punching shear areas shall be defined as follows:

a) Definition of the solid areas through the shear force verification in consideration of the reduced shear resistance of the Cobiax CLS slab $V_{Rd,c,cobiax}$ in accordance with Section 3.2.3.

b) For slabs without the need for punching shear reinforcement, the loaded area $A_{load}$ and the area that extends at least by 2.0 *d* past the basic control perimeter or that is necessary for the shear resistance of the COBIAX CLS slab to be reached - the greater value applies in each case - shall be designed as solid cross-sections. For slabs with enlarged column heads, the basic control perimeter is outside the enlarged column head.

c) For slabs with the need for punching shear reinforcement, in addition to b), it shall be verified that the solid area extends past the outer reinforcement row by 2.0 *d*. Otherwise the solid areas shall be extended accordingly.

The larger of the values of a), b) and c) shall apply.

The punching shear verifications of all verification sections of the solid areas including the outer section (1.5 *d* outside of the last reinforcement row) shall be carried out using $\beta\ V_{Ed}$.

As part of this, the transition to the shear resistance along the outer section shall be considered.

Where:

$\beta$ is the coefficient for the consideration of the non-rotationally-symmetric shear force distribution in accordance with DIN EN 1992-1-1 and DIN EN 1992-1-1/NA, Clause 6.4.3

$V_{Ed}$ design value of the total shear force to be resisted in accordance with DIN EN 1992-1-1 and DIN EN 1992-1-1/NA, Clause 6.4.3

$d$ mean effective depth of the voided slab; $d = (d_y + d_z) / 2$

### 3.2.5 Load capacity of disc

If the voided slab produced with CLS installation elements is loaded as a disc, only the area between the void former surface and the upper/lower edge of the slab with their net cross-sections may be used in calculation. They shall be sufficiently reinforced for this load and the design and detailing shall ensure that the forces to be transferred can be clearly transmitted.

### 3.2.6 Verifications of serviceability

The concrete edge compressive stress in the area between the void former surface and the upper/lower edge of the slab shall, in accordance with Section 7.2 (3) of DIN EN 1992-1-1 and DIN EN 1992-1-1/NA, be limited to the value $\leq 0.45 \cdot f_{ck}$ in the serviceability limit state under quasi-permanent action combination. Crack width control verification shall be carried out in accordance with DIN EN 1992-1-1 and DIN EN 1992-1-1/NA, Clause 7.3.

The minimum reinforcement for the crack width control shall be determined and inserted in accordance with DIN EN 1992-1-1 and DIN EN 1992-1-1/NA, Clause 7.3.2. When determining the minimum reinforcement, the solid cross-section of the slab (without taking the voids into account) shall be used mathematically.

Crack control width without direct calculation in accordance with Clause 7.3.3 of DIN EN 1992-1-1 and DIN EN 1992-1-1/NA is only permitted if the solid cross-section of the slab is used.

Deflection control verification shall be carried out in accordance with DIN EN 1992-1-1 and DIN EN 1992-1-1/NA, Clause 7.4.

The reduced flexural rigidity of the voided slab shall be taken into account in deflection analyses in both the uncracked and cracked cross-sections. For condition I, the reduction factors in accordance with Annex 2 may be applied.

### 3.2.7 Interface

If the voided slab is concreted in two passes, the interface in accordance with DIN EN 1992-1-1 and DIN EN 1992-1-1/NA, Clause 6.2.5, shall be verified for the net area of the construction joint $A_{i,red}$, whereby the joint shall be classified as 'smooth'.
For determining the construction joint net area in the area with structural formers $A_{i,red}$, the entire plan area of the CLS installation elements including the connections shall be deducted mathematically. To determine the net area in the area with structural formers, a reduction factor according to the following equation (2) shall thus be taken into account:

$$A_{i,red} = 0.21 * A_i \qquad \text{Equation (2)}$$

For $A_{i,red}$, a connecting reinforcement shall be designed and arranged in accordance with DIN EN 1992-1-1 and DIN EN 1992-1-1/NA.

The minimum shear force reinforcement in accordance with Section 3.2.3 to be installed in any case, even if no connecting reinforcement is mathematically required (even if concreting is carried out without intermediate interruption and no bond proof is required), may be counted towards the required connecting reinforcement.

The connecting reinforcement and shear reinforcement assemblies shall be placed in the X zone of the structural formers while the concrete cover to the structural former is maintained. They shall be secured in their position against displacement during concreting. If necessary, additional structural reinforcement bars must be provided for this and shown in the installation plan.

Anchoring of the connecting reinforcement on both sides of the interface shall be verified and ensured during execution.

For the first concreting section, the planned position of the interface shall be defined. The planned concreting depth and the required concrete amount shall be specified in the general arrangement plan.

If the voided slab is executed without an intermediate interruption, suitable means shall be provided to ensure that the CLS installation elements are secured against uplift and lateral displacement.

If the solid area of the slab (area without structural formers) is also concreted in two passes, the interface in this area shall be verified in accordance with DIN EN 1992-1-1 and DIN EN 1992-1-1/NA, Clause 6.2.5, whereby the joint shall be classified as 'smooth', see also Section 3.1.1.

### 3.2.8 Slab penetrations and recesses

The structural analysis and design of the planned slab recesses shall be planned and executed in accordance with DIN EN 1992-1-1, DIN EN 1992-1-1/NA and the provisions of this decision. The recess edges shall be designed in accordance with Section 3.1.7 of this decision.

Taking into account the reduced redistribution capacity of the voided slab, the transmission of the internal forces and moments in the area bordering the recess shall be taken into account separately.

If holes or cores up to a maximum diameter of 350 mm are subsequently required in the areas of the structural formers or between the structural formers, the weakened slab cross section shall be verified by means of structural analysis.

For the shear resistance, due to the weakening of the relevant cross section, a reduction factor of 0.5 shall be taken into account in accordance with the following equation (3):

$$V_{Rd,c,cobiax,red} = 0.50 * V_{Rd,c,cobiax} \qquad \text{Equation (3)}$$

Where:

$V_{Rd,c,cobiax,red}$ reduced design the shear resistance of the COBIAX CLS slab as a result of a borehole ∅ ≤ 350 mm

$V_{Rd,c,cobiax}$ design shear resistance of the COBIAX CLS slab in accordance with Section 3.2.3 Equation (1)

The spacing of the holes in every direction shall not be less than 2400 mm.

The above-mentioned minimum spacing of the holes applies in the structural former area and in a solid area with the width of the slab height around the structural former areas.

In addition, it shall be ensured that the continuous slab strips between two adjacent holes are maintained in every direction in the entire slab area concerned.

Larger slab penetrations with dimensions > 350 mm to be executed subsequently shall be verified by means of structural analysis taking into account the provisions of this decision. The static and structural requirements as for the planned recesses shall be adhered to or newly created in a suitable way.

### 3.2.9 Fire safety

3.2.9.1 Reaction to fire

The load-bearing and stiffening components of the COBIAX slab as well as the continuous layers at component level consist of the non-combustible building material concrete, and on the inside of void formers made of flammable (*normalentflammbar*) plastic (permanent formwork).

In the approval procedure, it was demonstrated that the COBIAX slab meets the requirements for components made of non-combustible building materials to the same extent.

3.2.9.2 Fire resistance

In the event of fire resistance requirements, the COBIAX CLS slabs may be used in places where in terms of fire resistance the following regulatory requirements for slabs apply: fire-retardant (*feuerhemmend*), highly fire-retardant (*hochfeuerhemmend*) or fire-resistant (*feuerbeständig*) are met.

Verification of the regulatory fire resistance requirements shall be provided as stated in the following and is given for a fire resistance duration of 30, 60 or 90 minutes.

The fire resistance duration indicated relates to the application of the subject of approval as described in Section 1 of this decision and relates to the load-bearing capacity (stability) and the fire integrity additionally required for slabs provided that:

- the support of the slab in terms of load-bearing capacity at least meets the same regulatory requirement as is imposed on the slab and
- transitions or connections to adjacent structural members and supports in terms of fire integrity are designed such that they meet the same regulatory requirement as is imposed on the slab.

To achieve fire resistance for COBIAX CLS slabs, the spacing of the structurally effective flexural reinforcement shall be increased from the underside of the slab compared to reinforced concrete solid slabs. For fire resistance verification, the temperature in the structurally effective flexural reinforcement is determined in accordance with DIN EN 1992-1-2 taking into account the cross-sectional geometry. This temperature shall not be higher than the temperature arising in accordance with DIN EN 1992-1-2 for the reinforcing steel of a reinforced concrete solid slab with the same fire resistance duration. Specification of a fire resistance duration of greater than 90 minutes is possible according to the results of the calculation in accordance with DIN EN 1992-1-2.

The verification is deemed to have been provided

a) if the above-mentioned limitation of the temperature of the reinforcing steel is ensured for the corresponding duration of fire resistance through compliance with the spacings of the

structurally effective flexural reinforcement from the slab underside $a_{HK}$ in accordance with DIN EN 1992-1-2 and

b) if, in the event of solid precast slabs, the joints between the prefabricated elements are formed in accordance with DIN EN 1992-1-2, 4.6.

DIN EN 1992-1-2 shall always apply in conjunction with DIN EN 1992-1-2/NA.

The determined fire resistance applies both to the fire exposure from the bottom and to the fire exposure from the top (fire from top to bottom).

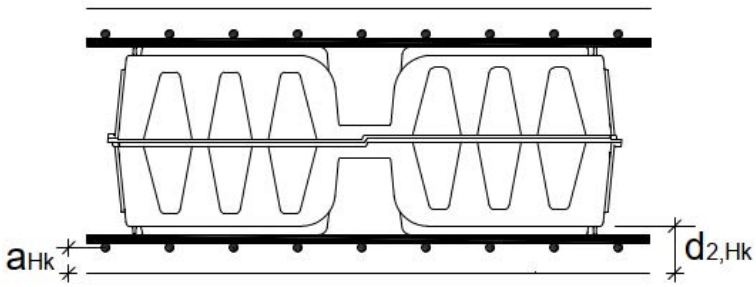
Regardless of the fire resistance duration, a minimum value of $d_{2,HK} \geq 7$ cm (see Figure 1) shall be complied with for the distance from the void former surface (without the spacer strip) to lower edge of the slab $d_{2,HK}$.

When the COBIAX CLS installation elements CLS-P-100 or CLS-P-110 to CLS-P-180 or CLS-P-190 are used, in addition to the specifications for the minimum thicknesses in accordance with Annex 1 of the decision, the thicknesses of the reinforced concrete slabs shall not be less than the values of Table 1.

**Table 1: Minimum slab thicknesses for execution with CLS-P-100/CLS-P-110 to CLS-P-180/CLS-P-190**

| COBIAX CLS type | CLS-P-100<br>CLS-P-110 | CLS-P-120<br>CLS-P-130 | CLS-P-140<br>CLS-P-150 | CLS-P-160<br>CLS-P-170 | CLS-P-180<br>CLS-P-190 |
|---|---|---|---|---|---|
| Minimum slab thickness $h_{min}$ [cm] | 21 | 23 | 25 | 27 | 29 |

**Figure 1: Cross-section of voided slab system 'Cobiax CLS'**




### 3.2.10 Thermal and sound insulation

The verifications for thermal and sound insulation are not the subject of this decision.

## 3.3 Execution

### 3.3.1 General

The COBIAX CLS installation elements shall be installed only in in-situ concrete slabs and in individual room-sized solid precast slabs.

Installation of the COBIAX CLS installation elements in or on semi-precast slabs with in-situ concrete toppings and in slabs composed of individual precast elements is not covered by this decision.

For the execution, DIN EN 13670 in conjunction with DIN 1045-3 shall apply with the supplementary provisions given below. For the production of the concrete, DIN EN 206-1 in conjunction with DIN 1045-2 shall apply.

In the manufacture of individual room-sized solid precast slabs with COBIAX CLS installation elements, the provisions in accordance with DIN 1045-4 shall also be taken into account.

To ensure the quality of execution and guarantee the stability of the voided slab with COBIAX CLS, the provisions for execution in Section 3.3 of this decision shall be considered and complied with for every execution.

All checks, tests and measures carried out during the execution shall be documented and filed in the construction records.

### 3.3.2 Reinforcement

The reinforcement shall be installed in accordance with the execution planning, taking into account the provisions of this decision.

### 3.3.3 Installation and concreting

Damaged COBIAX CLS installation elements shall not be installed. The shape stability of the structural formers shall be checked and ensured prior to concreting - particularly in summery temperatures.

During execution, careful installation and securing in position of the COBIAX CLS installation elements in accordance with the execution planning shall be ensured. For this, layout drawings with the corresponding representations and information shall be submitted. The installation of the structural formers shall be carried out in accordance with the execution planning, without offset between the structural formers, and shall be checked using an appropriate installation aid (installation cross). Installation of the structural formers with an offset greater than 10 mm is not permitted, see Annex 3.

Installation of the structural formers and the concrete covers of the reinforcement shall be monitored by the responsible site manager prior to concreting.

The fresh concrete properties (in particular the consistency of the fresh concrete) and the maximum grain size of the aggregate shall be matched to the geometry of the structural formers as well as the bar spacing of the reinforcing steel (between each other and towards the structural formers) so that the concrete can be placed and compacted properly.

The consistency of the fresh concrete shall have a flow table of classes F3 to F4, but shall not be higher than F4. The maximum grain size is 16 mm. In special cases (e.g. with dense reinforcement), the fresh concrete characteristics required for such cases shall be planned and monitored specifically from a concrete technology perspective, taking into account the compaction methods.

During concreting, the COBIAX CLS installation elements shall in each application case be secured through suitable measures to prevent them from rising or drifting off to the side.

For executing a planned horizontal construction joint, the concrete amounts for the first concrete layer, the concreting depths and compliance with the spacings of the structural formers shall be checked and documented in the construction records. Uniform and full-coverage concrete distribution - with compliance of concreting depths - shall be ensured. Concrete accumulations shall be avoided.

Furthermore, sufficient compaction of the first concrete layer shall be ensured so that the regions under the structural formers can also be compacted without any air inclusions and the reinforcement can be enveloped in concrete, whereby each intermediate region (X zone) of the structural formers shall be compacted.

The planned type of placement of the first concrete layer (placement at the edge of the structural former area resp. at the transition to the solid area of the slab or full-surface concreting of the first concrete layer) shall not be deviated from without approval by the designer.

The required anchoring of the shear reinforcement assemblies and the connecting reinforcement on both sides of the interface shall be monitored and ensured during execution and checked and documented after the first concreting section.

If the concreting depth is not complied with, the designer shall be involved. In such cases, it may become necessary to have the load-bearing capacity of the voided slab assessed by an

expert. This also applies if the required anchoring of the shear reinforcement assemblies or of the connecting reinforcement is less than required.

The second concrete layer shall not be poured until the first layer has sufficiently stiffened.

Prior to pouring the second concrete layer, the construction joint shall be pre-treated, cleaned and pre-wetted in accordance with the provisions of DIN EN 13670 in conjunction with DIN 1045-3. The concrete in the second layer shall be compacted carefully and cautiously in order to prevent structural and bonding failures in the first layer which has already started to stiffen. In this process, the structural formers must not float upwards; otherwise the load-bearing behaviour of the voided slab shall be subject to expert evaluation. This also applies to structural and bonding failures in the first layer which has already started to stiffen.

It shall be ensured that before and during concreting, no water collects in the structural formers.

Conduits shall not be routed in the areas of the structural formers and their concrete ribs if their external diameter exceeds 25 mm. For this, additional solid areas with solid cross-sections shall be formed.

Installation parts and conduits with a smaller external diameter ($ø \leq 25$ mm) may only be installed in compliance with the planning specifications and in consideration of Sections 3.1.8 of this decision. The positions of the conduits and installation parts, their spacings and their fixings shall be checked and documented in the construction records.

Conduits ($ø \leq 25$ mm) shall be securely fixed into position and shall be routed only to the nearest slab surface.

An installation reinforcement for attaching the conduits and fixing them in position shall be provided for, if necessary.

Drilling of holes, e.g. for installation cables, shall be carried out only by skilled workers. Slab penetrations shall be planned and executed in accordance with Section 3.2.8 of this decision. Drilled holes in areas of voids shall be subsequently sealed so that water penetration is not possible.

If during the construction period, point loads higher than 10 kN up to a characteristic value of 40 kN at maximum are applied, a suitable structure (e.g. load-distribution plates, cross arms made of steel or timber beams) enabling load distribution over several loading points shall be inserted and designed in order to satisfy the conditions in accordance with Section 3.2.4 of this decision.

During execution the installation instructions (Annex 3) shall be considered. Installation instructions shall be provided with each delivery.

### 3.3.4 Additional provisions when installing COBIAX CLS installation elements in individual solid precast slabs

When installing the COBIAX CLS installation elements in individual room-sized solid precast slabs, the storage, transport and condition shall additionally be taken into account.

For the installation of the transport anchors, solid areas without voids shall be formed. Sufficient anchoring and edge distances of the transport anchors shall be ensured in the process. In addition, the load-bearing capacity shall be verified taking into account the arising shear forces from the transport anchors in the prefabricated element. If multiple prefabricated elements are stacked on top of each other during storage or transport, the limitation of point loads above the structural formers in accordance with Section 3.2.4 of this decision shall be accounted for.

The individual prefabricated elements can be load-bearing in one or more directions. Design is carried out in accordance with the provisions for planning and design of this decision including required solid areas and edge formation. Section 3.1.3 shall be considered for the support area.

For the connection and supporting of the precast elements, Clause 10.9.4 of DIN EN 1992-1-1 and DIN EN 1992-1-1/NA shall be considered.

The Technical Building Rules shall be additionally complied with for the prefabricated slabs.

### 3.3.5 Additional provisions for the installer and manufacturer

Prior to the first concreting for a construction project with the COBIAX CLS slab system, the manufacturer of the COBIAX CLS installation elements shall conduct a briefing for the construction site management of the executing company (installer). The provisions of this decision, particularly the provisions for execution, and the installation instructions shall be explained. Verification of this briefing shall be submitted in written form to the client and added to the construction records.

The installer of the construction technique or the executing company shall provide a declaration of conformity in accordance with Sections 16 a (5) and 21 (2) of the Model Building Code to confirm the conformity of the construction technique with this general construction technique permit.

Unless otherwise specified, the following standards are referred to in this decision:

| | |
|---|---|
| DIN 488-1:2009-08 | Reinforcing steels – Part 1: Grades, properties, marking |
| 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 1045-3:2012-03 | Concrete, reinforced and prestressed concrete structures – Part 3: |
| + Corrigendum 1 | Execution of structures – Application rules for DIN EN 13670 DIN 1045-3/Corrigendum 1:2013-07 |
| DIN 1045-4:2012-02 | Concrete, reinforced and prestressed concrete structures – Part 4: Additional rules for the production and the conformity of prefabricated elements |
| DIN EN 206-1:2001-7/A1+A2 | Concrete – Part 1: Specification, performance, production and conformity<br>DIN EN 206-1/A1:2004-10 Amendment A1<br>DIN EN 206-1/A2:2005-09 Amendment A2 |
| DIN EN 1992-1-1:2011-01+A1 | Eurocode 2: Design of concrete structures – Part 1-1: General rules and rules for buildings; German version EN 1992-1-1:2004+AC:2010<br>DIN EN 1992-1-1/A1:2015-03 Amendment A1 and |
| DIN EN 1992-1-1/NA:2013-04 | National Annex – Nationally determined parameters – Eurocode 2: |
| + A1 | Design of concrete structures – Part 1-1: General rules and rules for buildings, DIN EN 1992-1-1/NA/A1:2015-12 |
| 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: |
| + A1 | Design of concrete structures – Part 1-2: General rules – Structural fire design, DIN EN 1992-1-2/NA/A1:2015-09 |
| DIN EN 13670:2011-03 | Execution of concrete structures; German version EN 13670:2009 |

Dr.-Ing. Lars Eckfeldt
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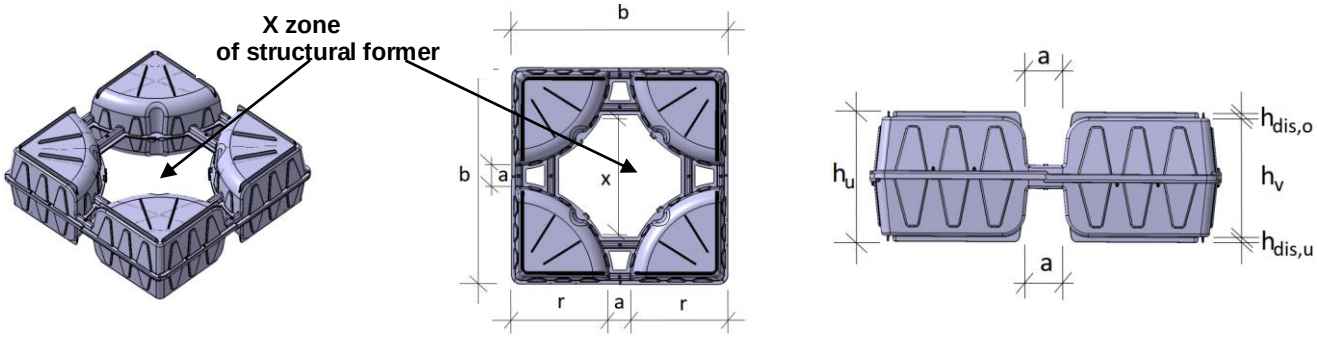
**Fig. 1: Structural former (rib height top and bottom = 10 mm) and representation of X zone**




**Spatial representation** **Top view** **View**

**Structural former - building material:** comprising two structural former halves (half shells) made of HD-PE resp. PP in accordance with the data sheet deposited with external surveillance body and DIBt

**Structural former - requirement**: shape stability for installation and concreting

**Product data**

| COBIAX CLS | CLS-P-100 | CLS-P-120 | CLS-P-140 | CLS-P-160 | CLS-P-180 | CLS-P-200 | CLS-P-220 | CLS-P-240 | CLS-P-260 | CLS-P-280 | CLS-P-300 | CLS-P-320 | CLS-P-340 | CLS-P-360 | CLS-P-380 | CLS-P-400 | CLS-P-420 | CLS-P-440 | CLS-P-460 | CLS-P-480 | CLS-P-500 | CLS-P-520 | CLS-P-540 | CLS-P-560 | CLS-P-580 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Width of structural former b [cm] | 60 | | | | | | | | | | | | | | | | | | | | | | | | |
| Minimum channel width a [cm] | 6 | | | | | | | | | | | | | | | | | | | | | | | | |
| Width of X zone [cm] | 34 | | | | | | | | | | | | | | | | | | | | | | | | |
| Radius CLS quadrant r [cm] | 27 | | | | | | | | | | | | | | | | | | | | | | | | |
| Height of structural former $h_u$ [cm] | 10 | 12 | 14 | 16 | 18 | 20 | 22 | 24 | 26 | 28 | 30 | 32 | 34 | 36 | 38 | 40 | 42 | 44 | 46 | 48 | 50 | 52 | 54 | 56 | 58 |
| Height of void $h_V$ [cm] | 8 | 10 | 12 | 14 | 16 | 18 | 20 | 22 | 24 | 26 | 28 | 30 | 32 | 34 | 36 | 38 | 40 | 42 | 44 | 46 | 48 | 50 | 52 | 54 | 56 |
| Height of spacer strip $h_{dis,o}/h_{dis,u}$ [mm] | 10 | | | | | | | | | | | | | | | | | | | | | | | | |
| Wall thickness [mm] | 1.3 - 1.7 | | | | | | | | | | | | | | | | | | | | | | | | |
| Weight [g/structural former] | 1700 - 5000 | | | | | | | | | | | | | | | | | | | | | | | | |
| Structural formers per m² [pieces] | 2.78 | | | | | | | | | | | | | | | | | | | | | | | | |
| Spacing e [cm] | 60 | | | | | | | | | | | | | | | | | | | | | | | | |
| min. slab thickness $h_{min}$ [cm] | 20.0 | 22.0 | 24.0 | 26.0 | 28.0 | 32.0 | 34.0 | 36.0 | 38.0 | 40.0 | 44.0 | 46.0 | 48.0 | 50.0 | 52.0 | 56.0 | 58.0 | 60.0 | 62.0 | 64.0 | 68.0 | 70.0 | 72.0 | 74.0 | 76.0 |
| min. distance from the void former surface (without the spacer strips) to the upper/lower edge of the slab [cm] | 6 | 6 | 6 | 6 | 6 | 7 | 7 | 7 | 7 | 7 | 8 | 8 | 8 | 8 | 8 | 9 | 9 | 9 | 9 | 9 | 10 | 10 | 10 | 10 | 10 |

For the minimum thicknesses of the slabs and distances from the void former surface (without the spacer strip) to the upper/lower edge of the slab, Sections 3.1.2, 3.1.8 and 3.2.9 of the decision shall also be observed.

Detailed information and dimensions of the structural formers are contained in the documents deposited with DIBt.

"COBIAX CLS" – a voided slab system

**Dimensions and product data for the Cobiax CLS installation element**
**Rib height (height of spacer strips) = 10 mm**

Annex 1
Sheet 1/2

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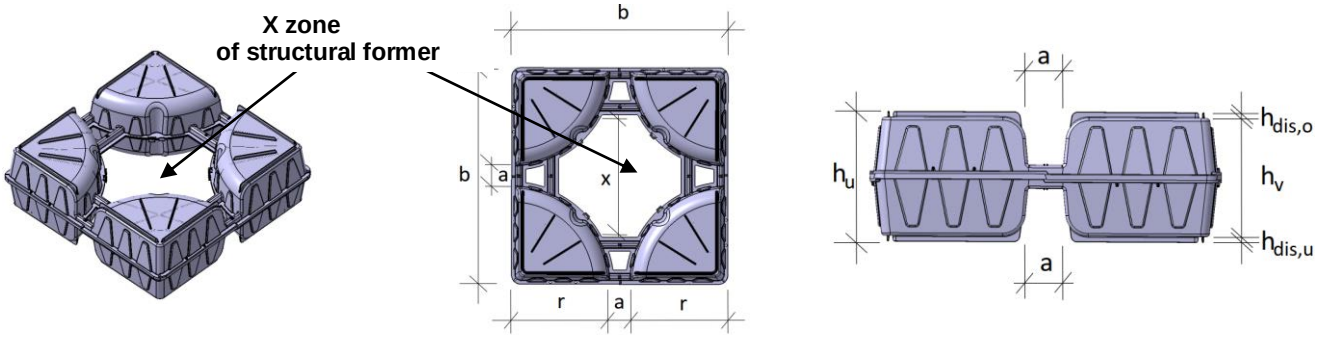
**Fig 2: Structural former (rib height top and bottom = 15 mm) and representation of the X zone**




**Spatial representation** **Top view** **View**

**Structural former - building material:** comprising two structural former halves (half shells) made of HD-PE resp. PP in accordance with the data sheet deposited with external surveillance body and DIBt

**Structural former - requirement**: shape stability for installation and concreting

**Product data**

| COBIAX CLS | CLS-P-110 | CLS-P-130 | CLS-P-150 | CLS-P-170 | CLS-P-190 | CLS-P-210 | CLS-P-230 | CLS-P-250 | CLS-P-270 | CLS-P-290 | CLS-P-310 | CLS-P-330 | CLS-P-350 | CLS-P-370 | CLS-P-390 | CLS-P-410 | CLS-P-430 | CLS-P-450 | CLS-P-470 | CLS-P-490 | CLS-P-510 | CLS-P-530 | CLS-P-550 | CLS-P-570 | CLS-P-590 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Width of structural former b [cm] | 60 | | | | | | | | | | | | | | | | | | | | | | | | |
| Minimum channel width a [cm] | 6 | | | | | | | | | | | | | | | | | | | | | | | | |
| Width of X zone [cm] | 34 | | | | | | | | | | | | | | | | | | | | | | | | |
| Radius CLS quadrant r [cm] | 27 | | | | | | | | | | | | | | | | | | | | | | | | |
| Height of structural former $h_u$ [cm] | 11 | 13 | 15 | 17 | 19 | 21 | 23 | 25 | 27 | 29 | 31 | 33 | 35 | 37 | 39 | 41 | 43 | 45 | 47 | 49 | 51 | 53 | 55 | 57 | 59 |
| Height of void $h_V$ [cm] | 8 | 10 | 12 | 14 | 16 | 18 | 20 | 22 | 24 | 26 | 28 | 30 | 32 | 34 | 36 | 38 | 40 | 42 | 44 | 46 | 48 | 50 | 52 | 54 | 56 |
| Height of spacer strip $h_{dis,o}/h_{dis,u}$ [mm] | 15 | | | | | | | | | | | | | | | | | | | | | | | | |
| Wall thickness [mm] | 1.3 - 1.7 | | | | | | | | | | | | | | | | | | | | | | | | |
| Weight [g/structural former] | 1700 - 5000 | | | | | | | | | | | | | | | | | | | | | | | | |
| Structural formers per m² [pieces] | 2.78 | | | | | | | | | | | | | | | | | | | | | | | | |
| Spacing e [cm] | 60 | | | | | | | | | | | | | | | | | | | | | | | | |
| min. slab thickness $h_{min}$[cm] | 20.0 | 22.0 | 24.0 | 26.0 | 28.0 | 32.0 | 34.0 | 36.0 | 38.0 | 40.0 | 44.0 | 46.0 | 48.0 | 50.0 | 52.0 | 56.0 | 58.0 | 60.0 | 62.0 | 64.0 | 68.0 | 70.0 | 72.0 | 74.0 | 76.0 |
| min. distance from the void former surface (without the spacer strips) to the upper/lower edge of the slab [cm] | 6 | 6 | 6 | 6 | 6 | 7 | 7 | 7 | 7 | 7 | 8 | 8 | 8 | 8 | 8 | 9 | 9 | 9 | 9 | 9 | 10 | 10 | 10 | 10 | 10 |

For the minimum thicknesses of the slabs and distances from the void former surface (without the spacer strip) to the upper/lower edge of the slab, Sections 3.1.2, 3.1.8 and 3.2.9 of the decision shall also be observed.

Detailed information and dimensions of the structural formers are contained in the documents deposited with DIBt.

"COBIAX CLS" – a voided slab system

**Dimensions and product data for the Cobiax CLS installation element**
**Rib height (height of spacer strips) = 15 mm**

Annex 1
Sheet 2/2

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## Stiffness factors for consideration of the reduction due to structural formers

Stiffness factors are given below (see following tables) for the voided slab for condition I to account for the reduction in stiffness due to the installed structural formers. With these factors, a deflection calculation can be carried out for the slabs, whereby the favourably acting reduced self-weight shall be taken into account, see Section 3.2.6 of the decision.

⇒$u_{cb}$ = distance from structural former to lower slab edge

| Slab height h [cm] | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Void height $D_{cb}$ [mm] | **100/110** (Type CLS-P-100 / CLS-P-110) | | | | | | | | | | | | | | | | | | |
| $I_{cb}/I_{solid}$ [-] centric | 0.95 | 0.96 | 0.97 | 0.97 | 0.98 | 0.98 | 0.98 | 0.98 | 0.98 | 0.99 | 0.99 | 0.99 | 0.99 | 0.99 | 0.99 | 0.99 | 0.99 | 0.99 | 0.99 |
| $I_{cb}/I_{solid}$ [-] $u_{cb}$ = 6 cm | 0.95 | 0.96 | 0.94 | 0.94 | 0.93 | 0.92 | 0.92 | 0.90 | 0.90 | 0.90 | 0.90 | 0.88 | | | | | | | |
| $I_{cb}/I_{solid}$ [-] $u_{cb}$ = 8 cm | | | 0.98 | 0.97 | 0.98 | 0.97 | 0.96 | 0.96 | 0.96 | 0.94 | 0.94 | 0.94 | 0.94 | 0.93 | 0.93 | 0.93 | 0.93 | 0.93 | 0.91 |

| Slab height h [cm] | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Void height $D_{cb}$ [mm] | **120/130** (Type CLS-P-120 / CLS-P-130) | | | | | | | | | | | | | | | | | | |
| $I_{cb}/I_{solid}$ [-] centric | 0.94 | 0.95 | 0.95 | 0.95 | 0.96 | 0.97 | 0.97 | 0.97 | 0.98 | 0.98 | 0.98 | 0.98 | 0.98 | 0.98 | 0.99 | 0.99 | 0.99 | 0.99 | 0.99 |
| $I_{cb}/I_{solid}$ [-] $u_{cb}$ = 6 cm | 0.94 | 0.94 | 0.92 | 0.92 | 0.92 | 0.90 | 0.90 | 0.90 | 0.90 | 0.88 | | | | | | | | | |
| $I_{cb}/I_{solid}$ [-] $u_{cb}$ = 8 cm | | | 0.96 | 0.96 | 0.96 | 0.96 | 0.96 | 0.96 | 0.94 | 0.94 | 0.94 | 0.93 | 0.92 | 0.92 | 0.92 | 0.92 | 0.91 | 0.91 | 0.91 |

| Slab height h [cm] | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Void height $D_{cb}$ [mm] | **140/150** (Type CLS-P-140 / CLS-P-150) | | | | | | | | | | | | | | | | | | |
| $I_{cb}/I_{solid}$ [-] centric | 0.92 | 0.93 | 0.93 | 0.95 | 0.95 | 0.95 | 0.96 | 0.97 | 0.97 | 0.97 | 0.97 | 0.97 | 0.97 | 0.98 | 0.98 | 0.98 | 0.98 | 0.98 | 0.98 |
| $I_{cb}/I_{solid}$ [-] $u_{cb}$ = 6 cm | 0.92 | 0.92 | 0.92 | 0.90 | 0.90 | 0.90 | 0.90 | 0.88 | | | | | | | | | | | |
| $I_{cb}/I_{solid}$ [-] $u_{cb}$ = 8 cm | | | 0.95 | 0.95 | 0.95 | 0.95 | 0.94 | 0.94 | 0.94 | 0.93 | 0.93 | 0.92 | 0.92 | 0.92 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 |

| Slab height h [cm] | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Void height $D_{cb}$ [mm] | **160/170** (Type CLS-P-160 / CLS-P-170) | | | | | | | | | | | | | | | | | | |
| $I_{cb}/I_{solid}$ [-] centric | 0.91 | 0.91 | 0.93 | 0.93 | 0.94 | 0.95 | 0.95 | 0.95 | 0.96 | 0.96 | 0.96 | 0.97 | 0.97 | 0.97 | 0.97 | 0.97 | 0.98 | 0.98 | 0.98 |
| $I_{cb}/I_{solid}$ [-] $u_{cb}$ = 6 cm | 0.91 | 0.90 | 0.90 | 0.90 | 0.90 | 0.88 | | | | | | | | | | | | | |
| $I_{cb}/I_{solid}$ [-] $u_{cb}$ = 8 cm | | | 0.93 | 0.94 | 0.94 | 0.94 | 0.94 | 0.93 | 0.93 | 0.93 | 0.93 | 0.92 | 0.91 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.88 |

| Slab height h [cm] | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 | 46 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Void height $D_{cb}$ [mm] | **180/190** (Type CLS-P-180 / CLS-P-190) | | | | | | | | | | | | | | | | | | |
| $I_{cb}/I_{solid}$ [-] centric | 0.89 | 0.90 | 0.91 | 0.91 | 0.93 | 0.93 | 0.94 | 0.95 | 0.95 | 0.95 | 0.96 | 0.96 | 0.96 | 0.96 | 0.96 | 0.97 | 0.97 | 0.97 | 0.97 |
| $I_{cb}/I_{solid}$ [-] $u_{cb}$ = 6 cm | 0.89 | 0.89 | 0.90 | 0.88 | | | | | | | | | | | | | | | |
| $I_{cb}/I_{solid}$ [-] $u_{cb}$ = 8 cm | | | 0.91 | 0.92 | 0.93 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.91 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.88 | 0.88 | 0.88 |

| Slab height h [cm] | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Void height $D_{cb}$ [mm] | **200/210** (Type CLS-P-200 / CLS-P-210) | | | | | | | | | | | | | | | | | | |
| $I_{cb}/I_{solid}$ [-] centric | 0.89 | 0.90 | 0.91 | 0.93 | 0.93 | 0.93 | 0.94 | 0.95 | 0.95 | 0.95 | 0.95 | 0.96 | 0.96 | 0.96 | 0.96 | 0.96 | 0.97 | | |
| $I_{cb}/I_{solid}$ [-] $u_{cb}$ = 7 cm | 0.89 | 0.89 | 0.90 | 0.90 | 0.90 | 0.88 | 0.88 | 0.88 | 0.88 | 0.88 | 0.88 | 0.88 | | | | | | | |
| $I_{cb}/I_{solid}$ [-] $u_{cb}$ = 9 cm | | | 0.91 | 0.92 | 0.93 | 0.93 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.91 | 0.91 | 0.90 | 0.90 | 0.90 | 0.9 | | |

| Slab height h [cm] | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 50 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Void height $D_{cb}$ [mm] | **220/230** (Type CLS-P-220 / CLS-P-230) | | | | | | | | | | | | | | | | | | |
| $I_{cb}/I_{solid}$ [-] centric | 0.88 | 0.89 | 0.91 | 0.91 | 0.91 | 0.93 | 0.93 | 0.93 | 0.94 | 0.95 | 0.95 | 0.95 | 0.95 | 0.96 | 0.96 | 0.96 | 0.96 | | |
| $I_{cb}/I_{solid}$ [-] $u_{cb}$ = 7 cm | 0.88 | 0.89 | 0.89 | 0.88 | 0.88 | 0.88 | 0.88 | 0.88 | 0.88 | 0.88 | | | | | | | | | |
| $I_{cb}/I_{solid}$ [-] $u_{cb}$ = 9 cm | | | 0.91 | 0.92 | 0.91 | 0.91 | 0.92 | 0.92 | 0.92 | 0.91 | 0.91 | 0.91 | 0.91 | 0.90 | 0.90 | 0.90 | 0.88 | | |

| Slab height h [cm] | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 50 | 51 | 52 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Void height $D_{cb}$ [mm] | **240/250** (Type CLS-P-240 / CLS-P-250) | | | | | | | | | | | | | | | | | | |
| $I_{cb}/I_{solid}$ [-] centric | 0.88 | 0.88 | 0.88 | 0.90 | 0.91 | 0.91 | 0.92 | 0.93 | 0.93 | 0.93 | 0.94 | 0.94 | 0.95 | 0.95 | 0.95 | 0.96 | 0.96 | | |
| $I_{cb}/I_{solid}$ [-] $u_{cb}$ = 7 cm | 0.88 | 0.87 | 0.87 | 0.87 | 0.87 | 0.88 | 0.88 | 0.88 | | | | | | | | | | | |
| $I_{cb}/I_{solid}$ [-] $u_{cb}$ = 9 cm | | | 0.89 | 0.90 | 0.91 | 0.91 | 0.91 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.88 | 0.88 | | |

| Slab height h [cm] | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 50 | 51 | 52 | 53 | 54 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Void height $D_{cb}$ [mm] | **260/270** (Type CLS-P-260 / CLS-P-270) | | | | | | | | | | | | | | | | | | |
| $I_{cb}/I_{solid}$ [-] centric | 0.85 | 0.88 | 0.88 | 0.88 | 0.90 | 0.91 | 0.91 | 0.91 | 0.92 | 0.93 | 0.93 | 0.93 | 0.94 | 0.94 | 0.94 | 0.95 | 0.95 | | |
| $I_{cb}/I_{solid}$ [-] $u_{cb}$ = 7 cm | 0.85 | 0.86 | 0.87 | 0.87 | 0.87 | 0.87 | | | | | | | | | | | | | |
| $I_{cb}/I_{solid}$ [-] $u_{cb}$ = 9 cm | | | 0.88 | 0.90 | 0.90 | 0.89 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.88 | 0.88 | 0.88 | 0.88 | 0.88 | | |

| Slab height h [cm] | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 50 | 51 | 52 | 53 | 54 | 55 | 56 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Void height $D_{cb}$ [mm] | **280/290** (Typ CLS-P-280CLS-P-290) | | | | | | | | | | | | | | | | | | |
| $I_{cb}/I_{solid}$ [-] centric | 0.85 | 0.85 | 0.88 | 0.88 | 0.88 | 0.90 | 0.91 | 0.91 | 0.91 | 0.92 | 0.92 | 0.93 | 0.93 | 0.93 | 0.94 | 0.94 | 0.94 | | |
| $I_{cb}/I_{solid}$ [-] $u_{cb}$ = 7 cm | 0.85 | 0.86 | 0.87 | 0.87 | | | | | | | | | | | | | | | |
| $I_{cb}/I_{solid}$ [-] $u_{cb}$ = 9 cm | | | 0.88 | 0.87 | 0.88 | 0.89 | 0.89 | 0.90 | 0.90 | 0.90 | 0.88 | 0.88 | 0.88 | 0.88 | 0.88 | 0.88 | 0.88 | | |

| Slab height h [cm] | 44 | 45 | 46 | 47 | 48 | 49 | 50 | 51 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Void height $D_{cb}$ [mm] | **300/310** (Type CLS-P-300 / CLS-P-310) | | | | | | | | | | | | | | | | | | |
| $I_{cb}/I_{solid}$ [-] centric | 0.85 | 0.87 | 0.88 | 0.88 | 0.89 | 0.90 | 0.91 | 0.91 | 0.91 | 0.92 | 0.92 | 0.93 | 0.93 | 0.93 | 0.94 | | | | |
| $I_{cb}/I_{solid}$ [-] $u_{cb}$ = 8 cm | 0.85 | 0.86 | 0.87 | 0.87 | 0.87 | 0.87 | 0.88 | 0.86 | 0.85 | 0.85 | 0.85 | 0.85 | | | | | | | |
| $I_{cb}/I_{solid}$ [-] $u_{cb}$ = 10 cm | | | 0.89 | 0.90 | 0.89 | 0.89 | 0.89 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.89 | 0.88 | 0.88 | | | | |
| Slab height h [cm] | 46 | 47 | 48 | 49 | 50 | 51 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | 60 | | | | |
| Void height $D_{cb}$ [mm] | **320/330** (Type CLS-P-320 / CLS-P-330) | | | | | | | | | | | | | | | | | | |
| $I_{cb}/I_{solid}$ [-] centric | 0.85 | 0.85 | 0.87 | 0.88 | 0.88 | 0.89 | 0.90 | 0.90 | 0.91 | 0.91 | 0.92 | 0.92 | 0.92 | 0.93 | 0.93 | | | | |
| $I_{cb}/I_{solid}$ [-] $u_{cb}$ = 8 cm | 0.85 | 0.86 | 0.86 | 0.87 | 0.87 | 0.85 | 0.85 | 0.85 | 0.85 | 0.85 | | | | | | | | | |
| $I_{cb}/I_{solid}$ [-] $u_{cb}$ = 10 cm | | | 0.86 | 0.87 | 0.88 | 0.88 | 0.89 | 0.90 | 0.90 | 0.90 | 0.88 | 0.88 | 0.88 | 0.88 | 0.88 | | | | |
| Slab height h [cm] | 48 | 49 | 50 | 51 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | 60 | 61 | 62 | | | | |
| Void height $D_{cb}$ [mm] | **340/350** (Type CLS-P-340 / CLS-P-350) | | | | | | | | | | | | | | | | | | |
| $I_{cb}/I_{solid}$ [-] centric | 0.84 | 0.85 | 0.86 | 0.87 | 0.87 | 0.88 | 0.89 | 0.90 | 0.90 | 0.90 | 0.91 | 0.91 | 0.92 | 0.92 | 0.93 | | | | |
| $I_{cb}/I_{solid}$ [-] $u_{cb}$ = 8 cm | 0.84 | 0.85 | 0.86 | 0.84 | 0.85 | 0.85 | 0.85 | 0.85 | | | | | | | | | | | |
| $I_{cb}/I_{solid}$ [-] $u_{cb}$ = 10 cm | | | 0.86 | 0.87 | 0.87 | 0.88 | 0.89 | 0.89 | 0.88 | 0.88 | 0.88 | 0.88 | 0.88 | 0.88 | 0.88 | | | | |
| Slab height h [cm] | 50 | 51 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | 60 | 61 | 62 | 63 | 64 | | | | |
| Void height $D_{cb}$ [mm] | **360/370** (Type CLS-P-360 / CLS-P-370) | | | | | | | | | | | | | | | | | | |
| $I_{cb}/I_{solid}$ [-] centric | 0.84 | 0.84 | 0.85 | 0.86 | 0.87 | 0.87 | 0.88 | 0.89 | 0.90 | 0.90 | 0.90 | 0.91 | 0.91 | 0.92 | 0.92 | | | | |
| $I_{cb}/I_{solid}$ [-] $u_{cb}$ = 8 cm | 0.84 | 0.83 | 0.83 | 0.84 | 0.85 | 0.84 | | | | | | | | | | | | | |
| $I_{cb}/I_{solid}$ [-] $u_{cb}$ = 10 cm | | | 0.86 | 0.87 | 0.87 | 0.88 | 0.87 | 0.87 | 0.87 | 0.88 | 0.88 | 0.88 | 0.88 | 0.88 | 0.88 | | | | |
| Slab height h [cm] | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | 60 | 61 | 62 | 63 | 64 | 65 | 66 | | | | |
| Void height $D_{cb}$ [mm] | **380/390** (Type CLS-P-380 / CLS-P-390) | | | | | | | | | | | | | | | | | | |
| $I_{cb}/I_{solid}$ [-] centric | 0.82 | 0.84 | 0.84 | 0.85 | 0.86 | 0.87 | 0.87 | 0.88 | 0.89 | 0.90 | 0.90 | 0.90 | 0.90 | 0.91 | 0.91 | | | | |
| $I_{cb}/I_{solid}$ [-] $u_{cb}$ = 8 cm | 0.82 | 0.83 | 0.83 | 0.84 | | | | | | | | | | | | | | | |
| $I_{cb}/I_{solid}$ [-] $u_{cb}$ = 10 cm | | | 0.86 | 0.86 | 0.86 | 0.86 | 0.86 | 0.87 | 0.87 | 0.87 | 0.88 | 0.88 | 0.88 | 0.88 | 0.86 | | | | |
| Slab height h [cm] | 56 | 57 | 58 | 59 | 60 | 61 | 62 | 63 | 64 | 65 | 66 | 67 | 68 | | | | | | |
| Void height $D_{cb}$ [mm] | **400/410** (Type CLS-P-400 / CLS-P-410) | | | | | | | | | | | | | | | | | | |
| $I_{cb}/I_{solid}$ [-] centric | 0.84 | 0.84 | 0.85 | 0.86 | 0.87 | 0.87 | 0.88 | 0.89 | 0.89 | 0.90 | 0.90 | 0.90 | 0.90 | | | | | | |
| $I_{cb}/I_{solid}$ [-] $u_{cb}$ = 9 cm | 0.84 | 0.85 | 0.85 | 0.84 | 0.84 | 0.85 | 0.85 | 0.85 | 0.85 | 0.85 | 0.85 | 0.85 | | | | | | | |
| $I_{cb}/I_{solid}$ [-] $u_{cb}$ = 11 cm | | | 0.86 | 0.86 | 0.87 | 0.88 | 0.87 | 0.87 | 0.87 | 0.87 | 0.88 | 0.88 | 0.88 | | | | | | |
| Slab height h [cm] | 58 | 59 | 60 | 61 | 62 | 63 | 64 | 65 | 66 | 67 | 68 | 69 | 70 | | | | | | |
| Void height $D_{cb}$ [mm] | **420/430** (Type CLS-P-420 / CLS-P-430) | | | | | | | | | | | | | | | | | | |
| $I_{cb}/I_{solid}$ [-] centric | 0.83 | 0.83 | 0.84 | 0.85 | 0.86 | 0.86 | 0.87 | 0.88 | 0.88 | 0.89 | 0.89 | 0.89 | 0.90 | | | | | | |
| $I_{cb}/I_{solid}$ [-] $u_{cb}$ = 9 cm | 0.83 | 0.83 | 0.83 | 0.83 | 0.83 | 0.84 | 0.84 | 0.84 | 0.84 | 0.84 | | | | | | | | | |
| $I_{cb}/I_{solid}$ [-] $u_{cb}$ = 11 cm | | | 0.85 | 0.85 | 0.86 | 0.86 | 0.86 | 0.86 | 0.86 | 0.86 | 0.86 | 0.86 | 0.87 | | | | | | |
| Slab height h [cm] | 60 | 61 | 62 | 63 | 64 | 65 | 66 | 67 | 68 | 69 | 70 | 71 | 72 | | | | | | |
| Void height $D_{cb}$ [mm] | **440/450** (Typ CLS-P-440 / CLS-P-450) | | | | | | | | | | | | | | | | | | |
| $I_{cb}/I_{solid}$ [-] centric | 0.82 | 0.83 | 0.84 | 0.84 | 0.85 | 0.85 | 0.86 | 0.87 | 0.87 | 0.89 | 0.89 | 0.89 | 0.90 | | | | | | |
| $I_{cb}/I_{solid}$ [-] $u_{cb}$ = 9 cm | 0.82 | 0.82 | 0.82 | 0.82 | 0.82 | 0.83 | 0.83 | 0.83 | | | | | | | | | | | |
| $I_{cb}/I_{solid}$ [-] $u_{cb}$ = 11 cm | | | 0.84 | 0.84 | 0.85 | 0.85 | 0.85 | 0.85 | 0.85 | 0.85 | 0.85 | 0.85 | 0.86 | | | | | | |
| Slab height h [cm] | 62 | 63 | 64 | 65 | 66 | 67 | 68 | 69 | 70 | 71 | 72 | 73 | 74 | | | | | | |
| Void height $D_{cb}$ [mm] | **460/470** (Type CLS-P-460 / CLS-P-470) | | | | | | | | | | | | | | | | | | |
| $I_{cb}/I_{solid}$ [-] centric | 0.81 | 0.82 | 0.84 | 0.84 | 0.84 | 0.85 | 0.86 | 0.87 | 0.87 | 0.88 | 0.88 | 0.88 | 0.90 | | | | | | |
| $I_{cb}/I_{solid}$ [-] $u_{cb}$ = 9 cm | 0.81 | 0.82 | 0.82 | 0.83 | 0.83 | 0.84 | | | | | | | | | | | | | |
| $I_{cb}/I_{solid}$ [-] $u_{cb}$ = 11 cm | | | 0.83 | 0.84 | 0.84 | 0.85 | 0.86 | 0.86 | 0.86 | 0.87 | 0.87 | 0.85 | 0.86 | | | | | | |
| Slab height h [cm] | 64 | 65 | 66 | 67 | 68 | 69 | 70 | 71 | 72 | 73 | 74 | 75 | 76 | | | | | | |
| Void height $D_{cb}$ [mm] | **480/490** (Type CLS-P-480 / CLS-P-490) | | | | | | | | | | | | | | | | | | |
| $I_{cb}/I_{solid}$ [-] centric | 0.81 | 0.81 | 0.83 | 0.83 | 0.83 | 0.84 | 0.85 | 0.86 | 0.86 | 0.87 | 0.87 | 0.88 | 0.89 | | | | | | |
| $I_{cb}/I_{solid}$ [-] $u_{cb}$ = 9 cm | 0.81 | 0.81 | 0.81 | 0.81 | | | | | | | | | | | | | | | |
| $I_{cb}/I_{solid}$ [-] $u_{cb}$ = 11 cm | | | 0.82 | 0.83 | 0.83 | 0.84 | 0.84 | 0.84 | 0.85 | 0.85 | 0.85 | 0.85 | 0.86 | | | | | | |

"COBIAX CLS" – a voided slab system

**Stiffness factors**

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| Slab height h [cm] | 68 | 69 | 70 | 71 | 72 | 73 | 74 | 75 | 76 | 77* | 78* | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Void height $D_{cb}$ [mm] | **500/510** (Type CLS-P-500 / CLS-P-510) | | | | | | | | | | | | | | | | | | |
| $I_{cb}/I_{solid}$ [-] centric | 0.81 | 0.81 | 0.84 | 0.84 | 0.84 | 0.85 | 0.85 | 0.86 | 0.87 | 0.87 | 0.88 | | | | | | | | |
| $I_{cb}/I_{solid}$ [-] $u_{cb}$ = 10 cm | 0.81 | 0.82 | 0.82 | 0.83 | 0.83 | 0.84 | 0.84 | 0.84 | 0.85 | 0.85 | 0.83 | | | | | | | | |
| $I_{cb}/I_{solid}$ [-] $u_{cb}$ = 12 cm | | | 0.83 | 0.84 | 0.84 | 0.85 | 0.86 | 0.86 | 0.86 | 0.86 | 0.85 | | | | | | | | |
| Slab height h [cm] | 70 | 71 | 72 | 73 | 74 | 75 | 76 | 77* | 78* | 79* | 80* | | | | | | | | |
| Void height $D_{cb}$ [mm] | **520/530** (Type CLS-P-520 / CLS-P-530) | | | | | | | | | | | | | | | | | | |
| $I_{cb}/I_{solid}$ [-] centric | 0.81 | 0.81 | 0.84 | 0.84 | 0.84 | 0.85 | 0.85 | 0.86 | 0.87 | 0.87 | 0.88 | | | | | | | | |
| $I_{cb}/I_{solid}$ [-] $u_{cb}$ = 10 cm | 0.81 | 0.82 | 0.82 | 0.83 | 0.83 | 0.84 | 0.84 | 0.84 | 0.85 | 0.85 | 0.83 | | | | | | | | |
| $I_{cb}/I_{solid}$ [-] $u_{cb}$ = 12 cm | | | 0.83 | 0.84 | 0.84 | 0.85 | 0.86 | 0.86 | 0.86 | 0.86 | 0.85 | | | | | | | | |
| Slab height h [cm] | 72 | 73 | 74 | 75 | 76 | 77* | 78* | 79* | 80* | | | | | | | | | | |
| Void height $D_{cb}$ [mm] | **540/550** (Type CLS-P-540 / CLS-P-550) | | | | | | | | | | | | | | | | | | |
| $I_{cb}/I_{solid}$ [-] centric | 0.81 | 0.81 | 0.83 | 0.83 | 0.83 | 0.84 | 0.84 | 0.86 | 0.86 | | | | | | | | | | |
| $I_{cb}/I_{solid}$ [-] $u_{cb}$ = 10 cm | 0.81 | 0.81 | 0.81 | 0.81 | 0.82 | 0.82 | 0.82 | 0.82 | 0.82 | | | | | | | | | | |
| $I_{cb}/I_{solid}$ [-] $u_{cb}$ = 12 cm | | | 0.83 | 0.83 | 0.83 | 0.84 | 0.84 | 0.84 | 0.84 | | | | | | | | | | |
| Slab height h [cm] | 74 | 75 | 76 | 77* | 78* | 79* | 80* | | | | | | | | | | | | |
| Void height $D_{cb}$ [mm] | **560/570** (Type CLS-P-560 / CLS-P-570) | | | | | | | | | | | | | | | | | | |
| $I_{cb}/I_{solid}$ [-] centric | 0.81 | 0.81 | 0.82 | 0.82 | 0.82 | 0.84 | 0.84 | | | | | | | | | | | | |
| $I_{cb}/I_{solid}$ [-] $u_{cb}$ = 10 cm | 0.81 | 0.81 | 0.81 | 0.81 | 0.81 | 0.82 | 0.82 | | | | | | | | | | | | |
| $I_{cb}/I_{solid}$ [-] $u_{cb}$ = 12 cm | | | 0.83 | 0.83 | 0.82 | 0.83 | 0.83 | | | | | | | | | | | | |
| Slab height h [cm] | 76 | 77* | 78* | 79* | 80* | | | | | | | | | | | | | | |
| Void height $D_{cb}$ [mm] | **580/590** (Type CLS-P-580 / CLS-P-590) | | | | | | | | | | | | | | | | | | |
| $I_{cb}/I_{solid}$ [-] centric | 0.81 | 0.81 | 0.81 | 0.81 | 0.82 | | | | | | | | | | | | | | |
| $I_{cb}/I_{solid}$ [-] $u_{cb}$ = 10 cm | 0.81 | 0.81 | 0.82 | 0.82 | 0.81 | | | | | | | | | | | | | | |
| $I_{cb}/I_{solid}$ [-] $u_{cb}$ = 12 cm | | | 0.83 | 0.83 | 0.82 | | | | | | | | | | | | | | |

* see Section 3.1.2 of the decision.

For calculating the flexural stiffness and the internal force of the voided slab, Section 3.2.1of the decision shall also be observed.
For the minimum thicknesses of the slabs and distances from the void former surface (without the spacer strip) to the upper/lower edge of the slab, Sections 3.1.2, 3.1.8 and 3.2.9 of the decision shall also be observed.

"COBIAX CLS" – a voided slab system

**Stiffness factors**

Annex 2
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Deutsches Institut für Bautechnik DIBt

**Installation instructions for the COBIAX CLS slab system**

**I. General**

The Cobiax CLS installation elements are installed on-site between the reinforcement layers of a reinforced concrete slab to reduce material consumption and self-weight.
For perfect and practicable execution of the voided slab, the provisions of the decision – especially Section 3.3 – as well as these installation instructions shall be observed and followed for each execution.
In the event of non-compliance with the specifications of the decision or the execution planning, such as position of the structural formers, concreting heights, consistency of the fresh concrete, anchorage of the reinforcement, etc., it is essential to contact and incorporate the designer.
All checks, tests and measures carried out during the execution shall be documented and filed in the construction records.

**II. Layout drawing for structural formers**

The installation is carried out in accordance with the execution plans and layout drawings, in which the voided slab areas, structural former types and their position, concreting heights, consistency of the fresh concrete, concrete covers, anchorage of the shear reinforcement assemblies and connecting reinforcements, etc. are defined and clearly shown on the basis of the structural design rules taking into account the valid national technical approval / general construction technique permit. In these plans, it is also essential to refer to these present installation instructions.

**III Fresh concrete properties:**

The information in Section 3.3.3 of the decision shall be observed for the fresh concrete properties.
The consistency of the fresh concrete shall have a flow table of classes F3 to F4, but shall not be higher than F4. The maximum grain size is 16 mm. In special cases (e.g. with dense reinforcement), the fresh concrete properties required for such cases shall be planned and monitored specifically taking into account the compaction actions taken.

**IV Installation procedure:**

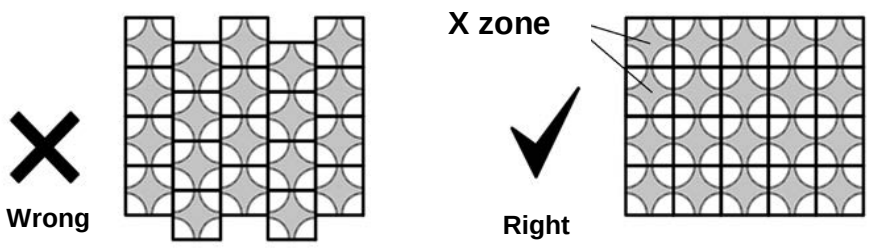
As for a conventional solid slab, the lower reinforcement is placed first (on spacers). In the next step, the COBIAX CLS installation elements are installed in accordance with the layout drawing. Then the upper reinforcement is placed. Next, the shear reinforcement assemblies and connecting reinforcements are installed.
The reinforcement is installed in accordance with the execution planning.

The arrangement of the shear reinforcement assemblies and connecting reinforcements in each intermediate area (X zone) of the structural formers is carried out in accordance with the execution planning, see also Fig. 4, Sheet 4/5.
The concrete covers are to be maintained in accordance with the execution planning and layout drawings (if necessary by means of additional spacers).

Particular attention must be paid to the following during installation:

- Install only undamaged COBIAX CLS installation elements. The shape stability of the structural formers shall be checked and ensured prior to concreting - particularly in summery temperatures.
- The structural formers are installed flush with each other without clearance so that there is full contact between the joint edges.
- The required anchorage of the shear reinforcement assemblies and connecting reinforcements shall be ensured on both sides of the interface (horizontal construction joint) in accordance with the execution planning.
- To maintain the concrete covers also towards the structural former surface and to compensate for height differences, suitable spacers (trestles and/or constructive reinforcement bars) shall be provided where necessary in accordance with the layout drawing, see Fig. 5, Sheet 4/5.
- The structural formers shall be connected to each other and to the lower reinforcement in a positionally secure way by means of appropriate fasteners (e.g. cable ties / binding wire), see Fig. 6 and Fig. 7, Sheet 5/5.
- The installation of the structural formers shall be carried out in accordance with the specified grid in the layout drawing without any offset between the structural formers, and shall be checked by means of a suitable installation aid (installation cross), see Fig 3 below.

**Fig. 3: Installation of the structural formers shall be made without offset**




Installing the structural former with an offset greater than 10 mm is not permitted.

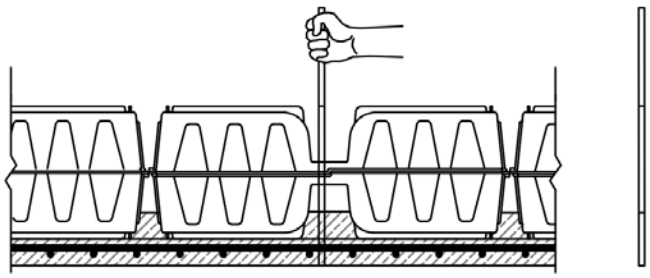
**V. Concreting operation:**

1) During the concreting operation, a buoyant force is exerted on the structural formers as a result of the voids. These shall therefore be secured in position using suitable measures, see Fig 6 and Fig 7, Sheet 5/5.
   If these securing measures are not sufficient for uninterrupted concreting, two concreting sections with a controlled construction joint are required in the structural former areas.
2) Practicable concrete compaction is decisive for the quality of execution. The concrete shall be carefully placed and compacted such that the reinforcement and the structural formers are densely surrounded by concrete. For this purpose, each X zone of the structural formers shall be compacted.
3) The concrete amounts for the first concrete layer and the concreting depths shall be planned, checked and documented in the construction records. Uniform and full-coverage concrete distribution shall be ensured – with concreting depths being maintained. Concrete accumulations shall be avoided. Furthermore, sufficient compaction of the first concrete layer shall be ensured so that the areas under the structural formers can also be filled with concrete without any air inclusions. As stipulated before, every X zone of the structural formers shall be compacted.

   **Caution**: The planned method of placing the first concrete layer (placement at the edge of the structural former area or at the transition to the solid area of the slab or full-surface concreting of the first concrete layer) shall not be deviated from without approval by the designer.

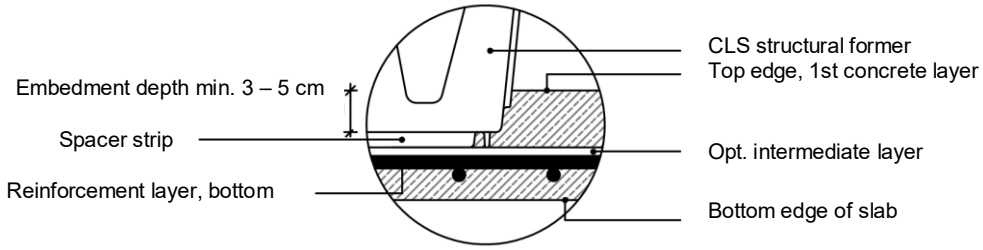
   The concreting depth and the position of the structural formers can be checked, e.g. by means of a marked rod during concreting. The markings depend on the information given in the layout drawing, see the following figure.

**Bar with depth markings**

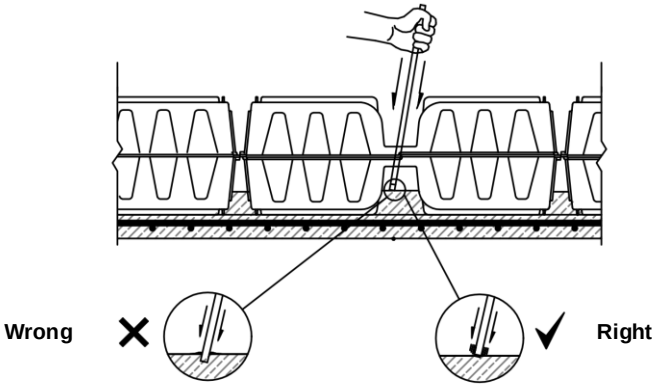


Bar with depth markings

4) The first concrete layer shall integrate the cavity of the structural former by at least 3 cm to 5 cm and without partial accumulations. Here, the required anchorage of the shear reinforcement assemblies and the connecting reinforcements shall be ensured in accordance with the execution planning, see the following figure.




5) The first hardened concrete layer fixes the structural formers during placement of the second concrete layer.
The second concrete layer shall not be placed until the first layer has sufficiently stiffened. The time of placement shall be selected such that the structural formers can no longer be pulled out of the first layer. An indicator for this time can be provided, e.g., by a pressure test done using an object (contact area approx. 3 cm x 3 cm). The lower concrete layer must no longer plastically deform when pressure is exerted on the surface, see the following figure.



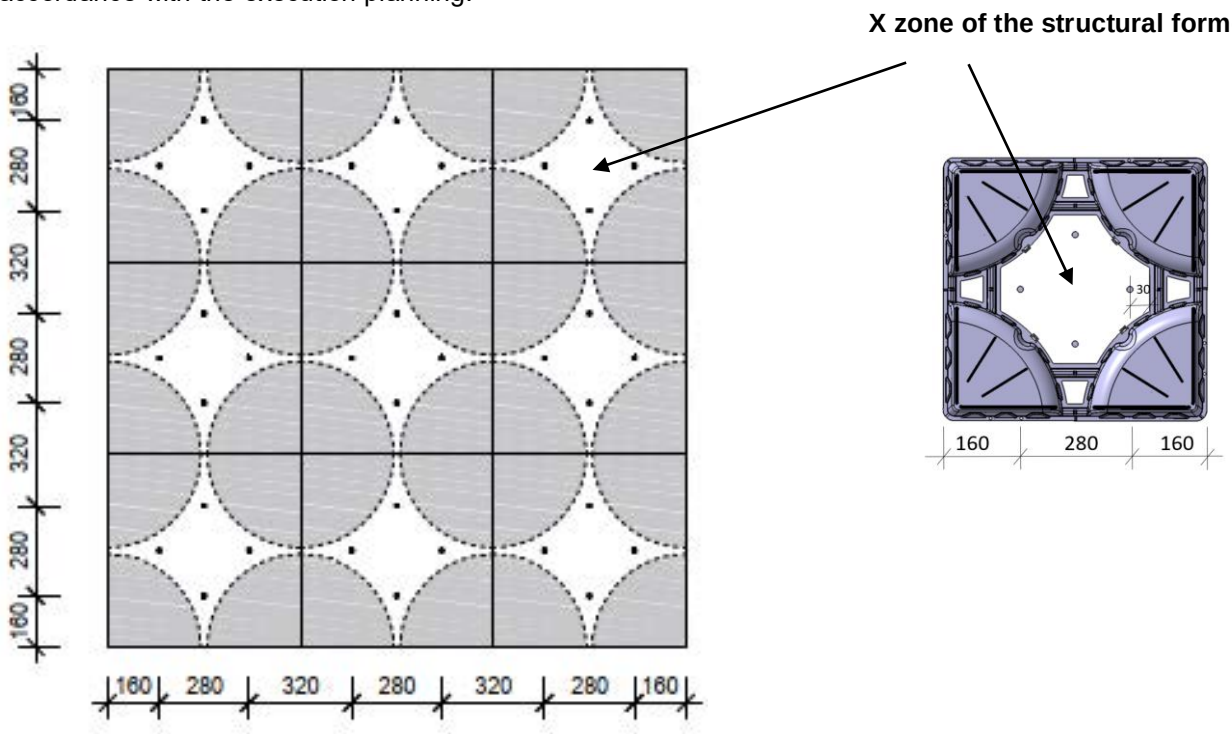

6) Before the second concrete layer is placed, the construction joint shall be completely cleared of dirt and pre-wetted. The embedment depth for the shear reinforcement assemblies and the connecting reinforcements shall also be checked.
7) The concrete of the second layer shall be carefully and gently compacted in order to prevent structural or bonding failures in the first layer which has already started to stiffen. In this process, the structural formers shall not float upwards.
8) It shall be ensured that no water collects in the structural formers before and during concreting.

**VI. Supplementary design requirements:**

1) For installation of conduits with an external diameter Ø ≤ 25 mm, the planning specifications and the regulations in accordance with Sections 3.1.8 and 3.3 of the decision shall be observed and complied with. The positions of the conduits and installation parts, their spacings and their fixings shall be checked and documented.
2) Slab penetrations shall be planned in accordance with Section 3.2.8 of the decision and executed only by skilled workers. Drilled holes in the area of the structural formers – even resulting from plug fixings – shall be subsequently sealed so that water penetration is not possible.
3) Necessary supports during the construction period shall be planned and executed taking into account the rules of this decision.

**Fig. 4: Arrangement of the shear reinforcement assemblies in the ground plan (see Section 3.2.3 of the decision)**

In each X zone of the structural formers, at least 4 shear reinforcement assemblies, diameter ≥ 8 mm, shall be installed. The shear reinforcement assemblies are installed on centre lines of the X zone of the structural formers and perpendicular to the slab plane, while maintaining the concrete cover to the structural former. They shall be secured so that they are not displaced during concreting. If necessary, additional structural reinforcement bars must be provided for this purpose. The connecting reinforcements shall be installed in accordance with the execution planning.




All figures in millimetres

**Fig. 5: Exemplary illustrations for suitable spacers to maintain the concrete covers and to compensate for height differences.**

(see DBV data sheets "Concrete cover and reinforcement", "Supports" and "Spacers").
The lower reinforcement shall always be laid on spacers.

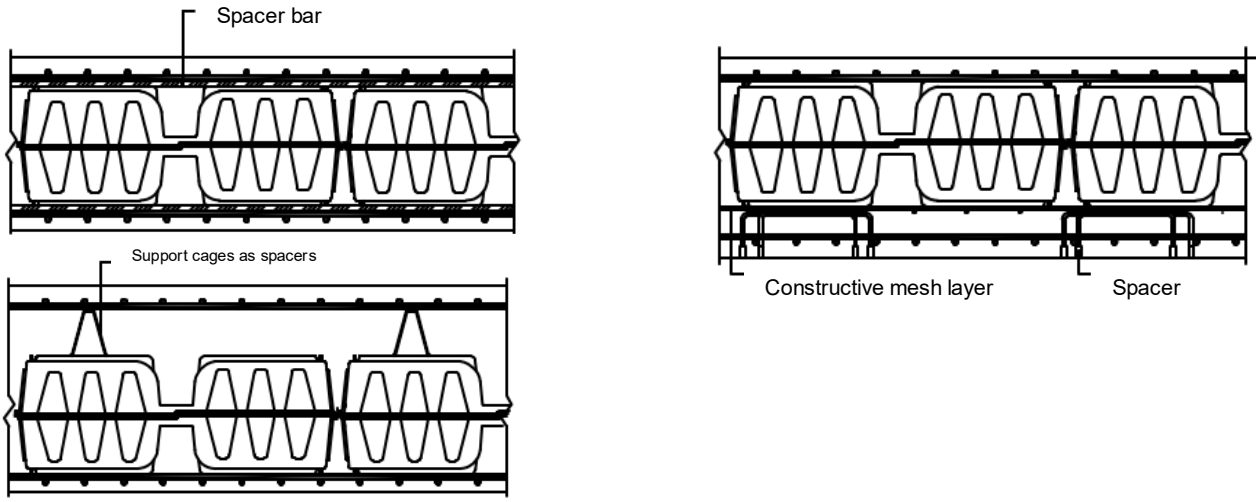


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**Fig 6: Fastening COBIAX CLS installation elements with the lower reinforcement of the slab**

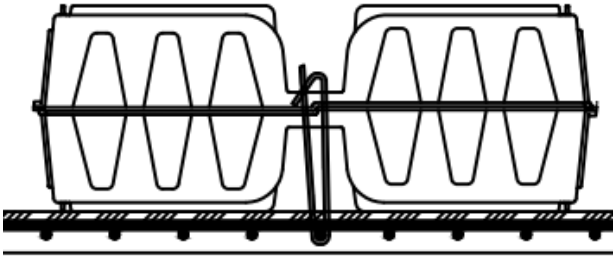
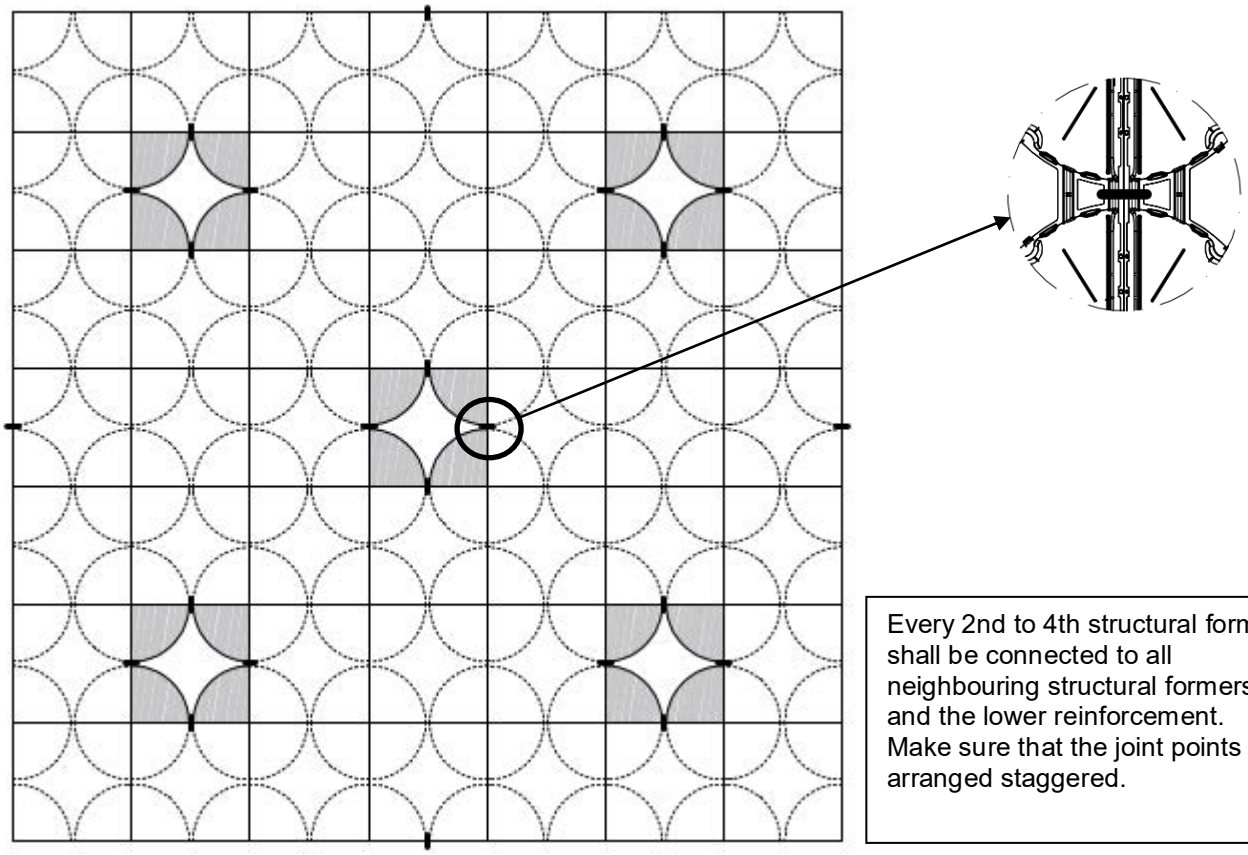


**Figure 7: Fastening the COBIAX CLS installation elements to each other**



Every 2nd to 4th structural former shall be connected to all neighbouring structural formers and the lower reinforcement. Make sure that the joint points are arranged staggered.

**Caution**: During concreting, the structural formers shall in each application case be secured with the help of suitable measures against uplift and lateral displacement. If the securing measures shown in Fig. 6 and Fig. 7 are not sufficient (e.g. when concreting the voided slab in one pass without interruption), additional securing measures shall be provided to fix the structural formers in their position or to secure them against uplift (floating up) and lateral displacement.
The securing measures shall be determined during planning and included in the layout drawings.