Deutsches Institut für Bautechnik
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Zulassungsstelle für Bauprodukte und Bauarten

Bautechnisches Prüfamt

Eine vom Bund und den Ländern
gemeinsam getragene Anstalt des öffentlichen Rechts

Mitglied der EOTA, der UEAtc und der WFTAO

General construction technique permit

Date: 23 Oct 2020

Reference: I 87-1.26.1-2/20

Number:
Z-26.1-44

Validity
from: **23 October 2020**
to: **23 October 2025**

Applicant:

Kingspan GmbH
Markenvertrieb Hoesch
Am Schornacker 2
46485 Wesel, Germany

Subject of decision:

Hoesch Additive Floor®

The subject named above is herewith granted a general construction technique permit.

This decision contains 16 pages and 18 annexes.

This general construction technique permit (*allgemeine Bauartgenehmigung*) replaces national technical approval (*allgemeine bauaufsichtliche Zulassung*) no. Z-26.1-44 of 8 August 2016. The subject of approval was granted the first national technical approval on 7 January 2003.

Translation authorised by DIBt

I GENERAL PROVISIONS

1 The general construction technique permit confirms the fitness for 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 installer of the subject concerned. The installer of the subject concerned shall also be made aware that this decision shall be made available at the 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 therein 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 on the subject concerned during the permit process. Alterations to this basis are not covered by this decision and shall be notified to DIBt without delay.

8 The general construction technique permit included in this decision also serves as a national technical approval for the construction technique.

II SPECIAL PROVISIONS

1 Subject concerned and field of application

The subject of the permit is the planning, design and execution of load-bearing slabs (floors) with the designation Hoesch Additive Floor® made of TRP 200 trapezoidal steel sheets (profiled steel sheeting), optional sheet metal parts and a ribbed reinforced concrete slab in accordance with DIN EN 1992-1-1[1] / DIN EN 1992-1-1/NA[2] as shown in Annexes 1 and 2. The ribbed reinforced concrete slab is constructed on site from concrete and reinforcing steel.

The profiled steel sheeting and the ribbed reinforced concrete slab are positioned on supports (steel or steel composite beams) by means of cleat bearings. The steel cleats are welded onto the upper flanges of the steel beams and protrude laterally.

The profiled steel sheets and the optional sheet metal parts are used as self-supporting formwork during construction.

In the ultimate limit state and serviceability limit state, the floor may be idealised as a chain of uniaxially spanned, pin-ended, single-span slabs.

When optional sheet metal parts are used and the ribbed reinforced concrete slab is concreted up to the web of the supporting beams in a mechanically interlocking manner, the slab may be regarded as a continuous slab.

For slab spans ≤ 6.00 m and imposed loads $q_k \leq 5.00$ kN/m² in accordance with DIN EN 1991-1-1[3], Clause 6.3, the anisotropic load-bearing behaviour of the slab may be disregarded in the design provided that the provisions of this general construction technique permit are complied with. For slab spans > 6.00 m, the anisotropic load-bearing behaviour of the slab shall always be taken into account.

Hoesch Additive Floor® may be used to resist static and quasi-static loads in accordance with DIN EN 1991-1-1[4], Clause 6.1 in conjunction with DIN EN 1991-1-1/NA[5], Table 6.1DE and Clause 6.3.1.2.

The planning, design and execution of the Hoesch Additive Floor® are subject to the applicable Technical Building Rules taking into account the specifications set out in this decision.

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 in conjunction with DIN EN 1992-1-1/A1:2015-03 Eurocode 2: Design of concrete structures – Part 1-1: General rules and rules for buildings; German version EN 1992-1-1:2004/A1:2014
2	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 in conjunction with DIN EN 1992-1-1/NA/A1:2015-12 National Annex – Nationally determined parameters – Eurocode 2: Design of concrete structures – Part 1-1: General rules and rules for buildings; Amendment A1
3	DIN EN 1991-1-1:2010-12	Eurocode 1: Actions on structures – Part 1-1: General actions – Densities, self-weight, imposed loads for buildings in conjunction with DIN EN 1991-1-1/NA:2010-12
4	DIN EN 1991-1-1:2010-12	Eurocode 1: Actions on structures – Part 1-1: General actions – Densities, self-weight, imposed loads for buildings in conjunction with DIN EN 1991-1-1/NA:2010-12
5	DIN EN 1991-1-1/NA:2010-12	National Annex – Nationally determined parameters – Eurocode 1: Actions on structures – Part 1-1: General actions – Densities, self-weight, imposed loads for buildings

2 Provisions for planning, design and execution

2.1 Planning

2.1.1 General

In addition to the planning requirements below, planning shall also take into account the provisions pertaining to design, as set out in Section 2.2, and execution, as set out in Section 2.3.

When using the slab for parking decks, the slab shall be constructed with a gradient of at least 1.5%. Sufficient drainage shall be ensured for the entire floor area.

2.1.2 Profiled steel sheets

The profiled steel sheets shall be made of a corrosion-protected sheet steel suitable for cold-forming in accordance with DIN EN 1090-2[6].

The starting material which has not yet been profiled shall have at least the mechanical characteristics of steel grade S350GD+Z in accordance with DIN EN 10346[7].

These requirements shall also be met by the finished product in its final state of use.

The nominal sheet thicknesses of the profiled steel sheets shall be approx. 1.00 mm, 1.13 mm, 1.25 mm or 1.50 mm. The corresponding structural minimum core sheet thicknesses t_{cor} of these profiled steel sheets shall be 0.96 mm, 1.09 mm, 1.21 mm and 1.46 mm respectively (with core sheet thickness = nominal sheet thickness minus coating thickness; $t_{cor} = t_{nom} - t_{metalliccoatings}$ for $t_{metalliccoatings} \leq 0.04$ mm).

The dimensions and dimensional tolerances of the profiled steel sheets given in Annexes 3 to 5 shall apply, as well as the specifications deposited with DIBt.

The tolerances in accordance with DIN EN 10143[8], Table 2 (standard dimensional tolerances) shall apply to the dimensional tolerances for the nominal sheet thickness, but only the restricted dimensional tolerances S shall apply to the lower dimensional tolerance values.

The factory production control of the manufacturer of the profiled steel sheets shall be certified in accordance with DIN EN 1090-1[9].

2.1.3 Corrosion protection of the profiled steel sheets

The provisions of DIN EN 10346[7], DIN EN 1090-2[6] and DIN 55634[10] shall apply.

As corrosion protection, at least one coating in accordance with coating ID Z275, ZA255 or AZ150 in accordance with DIN EN 10346[7] shall be provided.

[6] DIN EN 1090-2:2011-10 Execution of steel structures and aluminium structures – Part 2: Technical requirements for steel structures

[7] DIN EN 10346:2015-10 Continuously hot-dip coated steel flat products for cold forming – Technical delivery conditions

[8] DIN EN 10143:2006-09 Continuously hot-dip coated steel sheet and strip – Tolerances on dimensions and shape

[9] DIN EN 1090-1:2012-02 Execution of steel structures and aluminium structures – Part 1: Requirements for conformity assessment of structural components

[10] DIN 55634:2010-04 Paints, varnishes and coatings – Corrosion protection of supporting thin-walled building members made of steel

2.1.4 Reaction-to-fire of the profiled steel sheets

Uncoated and continuously galvanised profiled steel sheets meet the requirements for reaction-to-fire class A1 in accordance with DIN 4102-4[11] or class A1 in accordance with DIN EN 13501-1[12] pursuant to Commission Decision 96/603/EC.

2.1.5 Support of the profiled steel sheeting on steel cleats

The profiled steel sheeting shall be supported on steel cleats which are welded to the upper flange of the steel supporting beams in accordance with Annexes 3 to 5 and 14 to 16. The steel cleats shall be made of structural steel in accordance with the steel grades given in DIN EN 1993-1-1[13], Table 3.1. The dimensions and dimensional tolerances of the steel cleats shall correspond to the specifications given in Annexes 3 to 5 and 14 to 16, as well as the specifications deposited with DIBt.

The profiled steel sheeting shall be fastened to each cleat by means of power-actuated fasteners covered by a national technical approval or European Technical Assessment.

2.1.6 Sheet metal parts for manufacturing the ribbed reinforced concrete floor as a continuous slab

If sheet metal parts in accordance with Annexes 2 and 4 are attached to the ends of the profiled steel sheets and the ribbed reinforced concrete slab is concreted on both sides to the web of the steel supporting beam in a mechanically interlocking manner, the ribbed reinforced concrete slab shall be considered as a continuous slab.

The same specifications shall apply to the sheet metal parts as to the profiled steel sheets in accordance with Sections 2.1.2 to 2.1.4 in combination with the dimensions deposited with DIBt.

2.1.7 Ribbed reinforced concrete slab made of concrete and reinforcing steel

The ribbed reinforced concrete slab consists of concrete of strength classes C20/25 to C50/60 in accordance with DIN EN 206-1[14] in conjunction with DIN 1045-2[15] and reinforcing steel B500B in accordance with the DIN 488 series of standards[16].

The thickness of the concrete slab above the upper edge of the profiled steel sheeting shall be at least 80 mm.

2.1.8 Edging

The edge of the slab parallel to the ribs shall be planned and designed in accordance with Annex 10.

2.2 Design

2.2.1 General

In the final state, the profiled steel sheeting and the ribbed reinforced concrete slab bear the loads in an additive manner, i.e., no bond is assumed between the profiled steel sheeting and the ribbed reinforced concrete slab.

11	DIN 4102-4:2016-05	Fire behaviour of building materials and building components – Part 4: Synopsis and application of classified building materials, components and special components
12	DIN EN 13501-1:2010-01	Fire classification of construction products and building elements – Part 1: Classification using data from reaction to fire tests
13	DIN EN 1993-1-1:2010-12	Eurocode 3: Design of steel structures – Part 1-1: General design rules and rules for buildings in conjunction with DIN EN 1993-1-1/NA:2010-12
14	DIN EN 206-1:2001-07	Concrete – Part 2: Specification, performance, production and conformity
15	DIN 1045-2:2008-08	Concrete, reinforced and prestressed concrete structures – Part 2: Concrete – Specification, properties, production and conformity – Application rules for DIN EN 206-1
16	DIN 488 Parts 1 to 6	Reinforcing steels Part 1 to 5 Edition 2009-08, Part 6 Edition 2010-01

Unless otherwise specified below, the detailing and design (including the construction stages)

- of the steel members and the sheeting shall be subject to DIN EN 1993-1-3[17],
- of the ribbed reinforced concrete slab to DIN EN 1992-1-1[1] / DIN EN 1992-1-1/NA[2] and DIN EN 1992-1-2[18] as well as DIN EN 1994-1-1[19].

An arrangement of transverse ribs as described in DIN EN 1992-1-1[1] / DIN EN 1992-1-1/NA,[2] Clause 5.3.1, is not required.

The supporting beams shall be verified in accordance with the applicable Technical Building Rules taking into account the specifications set out in this decision.

The ribbed reinforced concrete slab may be taken into account as the compression flange of the composite steel beams provided that it is designed and detailed accordingly.

2.2.2 Reinforcement with reinforcing steel

Supplementary reinforcement shall be inserted into the ribs of the slab in accordance with Annexes 6 to 9 depending on structural requirements. For the lower longitudinal reinforcement of the ribs, at least one rebar Ø ≥ 8 mm shall be inserted per rib, continuous over the entire length of the profiled steel sheet.

As support reinforcement at intermediate and end supports, double-shear stirrups inclined at 45° shall be inserted into the ends of the concrete ribs (see Annexes 7, 8 and 9). The diameter of the stirrups shall be at least 6 mm.

Other necessary reinforcement (e.g., to resist the shoulder shear of composite beams) shall be verified separately.

An orthogonal reinforcement mesh of at least 2.00 cm²/m shall be inserted into the slab as slab reinforcement to prevent shrinkage cracks and ensure load distribution. The reinforcement may be taken into account in all structural verifications. DIN EN 1992-1-1[1] / DIN EN 1992-1-1/NA[2] shall apply to the concrete cover of the slab reinforcement.

2.2.3 Bracing

The ribbed reinforced concrete slab may be used as a diaphragm for horizontal bracing. In this case, the slab shall be verified and designed accordingly. The concrete slab shall be verified for combined slab and in-plane stress including verification of the load transfer.

2.2.4 Design of the profiled steel sheeting during the construction stages

2.2.4.1 Design loads

In addition to the self-weight of the profiled steel sheeting and the fresh concrete with reinforcement, the loads to be taken into account for concreting and other works shall be assumed to be those specified in DIN EN 1994-1-1[19], Clause 9.3.2, in conjunction with DIN EN 1991-1-6[20], Clause 4.11.2.

2.2.4.2 Ultimate limit state verification

DIN EN 1993-1-3[17] shall apply to the ultimate limit state verification of the profiled steel sheeting.

The design resistance values and design parameters for the profiled steel sheeting can be found in Annex 12. Cross joints of the sheets are not permitted.

If temporary intermediate supports are required during construction, they shall be designed in accordance with the structural requirements.

17	DIN EN 1993-1-3:2010:12	Eurocode 3: Design of steel structures – Part 1-3: General rules – Supplementary rules for cold-formed members and sheeting in conjunction with DIN EN 1993-1-3/NA:2010-12
18	DIN EN 1992-1-2:2010-12	Eurocode 2: Design of concrete structures – Part 1-2: General rules – Structural fire design in conjunction with DIN EN 1992-1-2/NA:2010-12
19	DIN EN 1994-1-1:2010-12	Eurocode 4: Design of composite steel and concrete structures – Part 1-1: General rules and rules for buildings in conjunction with DIN EN 1994-1-1/NA:2010-12
20	DIN EN 1991-1-6:2010-12	Eurocode 1: Actions on structures – Part 1-6: General actions, Actions during execution; in conjunction with DIN EN 1991-1-6/NA:2010-12

The shear forces acting on the profiled steel sheeting where it is supported on the cleat is decisive for shear resistance verification. The corresponding design shear resistance values $A_{K,Rd}$ per cleat are shown in Table 1. If the steel cleat is fastened to the steel beam in accordance with the design specifications given in Annexes 3, 4 or 5, a separate verification of the fastening is not required.

Table 1: $A_{K,Rd}$ – Design resistance values of the profiled steel sheeting where it is supported on the steel cleat

t_{nom}	[mm]	1.00	1.13	1.25	1.50
$A_{K,Rd}$	[kN]	7.9	9.3	10.8	14.1

The power-actuated fastener used to fasten the profiled steel sheet to the steel cleat shall be verified for horizontal shear resistance with a force $F_{Qd} = 0.25\ A_{K,Ed}$, where $A_{K,Ed}$ is the design value of the support reaction per steel cleat.

Possible torsional stress on the steel beams during concreting due to one-sided loading with fresh concrete shall be taken into account.

2.2.5 Design of the floor in its final state

2.2.5.1 General / calculation basis

The verification concept set out in DIN EN 1990[21] shall apply.

The ultimate limit state verification is based on the calculation model set out in Annex 11. It is characterised by the fact that

– the bending moment $M_{Ed,max}$ of the floor is resisted additively by the profiled steel sheeting and by the ribbed reinforced concrete slab and that

– the shear force $V_{Ed,max}$ in the area where the floor is supported is also additively resisted by the profiled steel sheeting and by the ribbed reinforced concrete slab. It shall be assumed that the individual profiled steel sheets are not supported during construction.

In the model, the load component $q_{c,Ed}$ of the line load acting on the reinforced concrete rib shall be transferred over the entire span L, while the load component $q_{PT,Ed}$ of the line load acting on the profiled steel sheeting shall be transferred over the span L_{PT}. The spacing between the points where the rib reinforcement is bent upwards is hereinafter referred to as L_c, see Annex 11. The design span L_{PT} of the profiled steel sheeting shall be the distance between the cleat supports. The span L shall correspond to the spacing of the supporting beams (steel or composite beams).

2.2.5.2 Design loads

For vertical imposed loads, for concentrated point loads or for line loads exceeding those listed below, special measures are required which are not covered by this construction technique permit.

In the case of traffic and parking areas for light vehicles (total load ≤ 30 kN), which are verified with a distributed load/imposed load $q_k \leq 5.0$ kN/m², verifications with axle load $2 \cdot Q_k$ or wheel load Q_k in accordance with DIN EN 1991-1-1[3], Clause 6.3.3 may be dispensed with, taking into account the stirrup reinforcement (support reinforcement) in accordance with Section 2.2.2.

Non-load-bearing lightweight partitions may be taken into account by adding Δq_k to the imposed load in accordance with DIN EN 1991-1-1[3], Clause 6.3.1.2(8). Unless a precise verification of sufficient lateral load distribution is provided, this design factor for the slab shall be increased by one third due to the anisotropic design of the slab.

21 DIN EN 1990:2010-12 Eurocode: Basis of structural design; in conjunction with DIN EN 1990/NA:2010-12

2.2.5.3 Ultimate limit state verifications

2.2.5.3.1 Verification of bending moment resistance

The moment resistance M_{Rd} shall be the sum of the flexural strengths of the profiled steel sheet ($M_{PT,Rd}$) and the ribbed reinforced concrete slab ($M_{c,Rd}$):

$$M_{Rd} = M_{PT,Rd} + M_{c,Rd} \quad (1)$$

The bending strength of the profiled steel sheeting shall be:

$$M_{PT,Rd} = M_{PT,Rk} / \gamma_{M1} \quad (2)$$

with γ_{M1} = 1.1 and $M_{PT,Rk}$ in accordance with Annex 12.

The flexural strength of the ribbed reinforced concrete slab $M_{c,Rd}$ shall be determined in accordance with DIN EN 1992-1-1[1] / DIN EN 1992-1-1/NA[2], Clause 6.1. The maximum design cross-sectional area of the reinforcement used shall be 2.6 cm² per rib, even if more reinforcement is inserted into the ribs, e.g. for fire protection reasons (see Section 3.4.3.6.2). For positive moment loading (pressure zone in the concrete), the moment resistance of the concrete slab $M_{c,Rd}$ may also be approximated to a plastic resistance moment and be determined in accordance with DIN EN 1994-1-1[19].

The load components $q_{PT,Ed}$ and $q_{c,Ed}$ resulting from the distribution of the design load q_{Ed} to the profiled steel sheeting and the ribbed reinforced concrete slab produce the following results in the case of uniform line loads:

$$q_{PT,Ed} = q_{Ed} \frac{M_{PT,Rd}(L / L_{PT})^2}{M_{c,Rd} + M_{PT,Rd}(L / L_{PT})^2} \geq q_{G,Ed} \quad (3)$$

$$q_{c,Ed} = q_{Ed} - q_{PT,Ed} \quad (4)$$

where $q_{G,Ed}$ is the design value of the action from the self-weight of the profiled steel sheeting and the self-weight of the concrete.

2.2.5.3.2 Shear resistance verification for the slab in the support area

The design shear resistance of the slab in the support area shall be composed of the shear resistance of the profiled steel sheeting and the ribbed reinforced concrete slab. The design shear resistance of the reinforced concrete rib is made up of a load-bearing component for the concrete and a load-bearing component for the reinforcement (inclined stirrup in accordance with Annexes 7 to 9 or, a supporting reinforcement in accordance with Annexes 17 and 18 which is at least equivalent to it). The resistance of the individual components cannot be fully utilised due to their varying deflection behaviour. This is taken into account by using the factors k_c and k_s in accordance with Table 2.

The following verification shall be provided for the profiled steel sheeting:

$$V_{PT,Ed} / V_{PT,Rd} \leq 1.0 \quad (5)$$

where:

$V_{PT,Ed}$ is the shear force of the profiled steel sheeting resulting from $q_{PT,Ed}$ at the point of the calculated cleat support

$V_{PT,Rd}$ = $V_{Rd,K}$ – is the design shear resistance component contributed by the profiled steel sheeting per pair of cleats or per rib in accordance with Table 6

If the steel cleat is fastened to the steel beam in accordance with the design specifications set out in Annexes 3, 4 or 5, a separate verification of the fastening is not required.

Verification of sufficient resistance is provided for the ribbed reinforced concrete slab if the condition

$V_{c,Ed} / V_{c,Rd} \leq 1.0$ (6)

is met.

where:

$V_{c,Ed}$ is the shear force resulting from the load component $q_{c,Ed}$ at the point of the calculated support of the ribbed reinforced concrete slab (see Annex 11)

$V_{c,Rd}$ is the design shear resistance for the effective area of a rib with a reference width of b = 750 mm, determined in accordance with equation (7):

$V_{c,Rd} = k_c \cdot V_{Rd,c,min} + k_s \cdot V_{Rd,s}$ (7)

where:

k_c, k_s are the factors for taking into account the varying deflection behaviour of the individual components in accordance with Table 2

$V_{Rd,c,min}$ is the minimum value of the shear resistance component of the concrete rib in accordance with Table 3 (design value)

$V_{Rd,s}$ is the shear resistance component contributed by the double-shear inclined stirrups in accordance with Annexes 7 to 9, which is given for intermediate supports in Table 4 and for end supports in Table 5 (design value)

Table 2: Factors k_c and k_s for taking into account the resistance contribution of the individual components

Components	Factor	Edge support	Intermediate support in accordance with Annex 3	Intermediate support in accordance with Annex 4
Concrete	k_c	0.50	0.60	0.30
Supporting reinforcement	k_s	0.85	1.00	1.00

Table 3: $V_{Rd,c,min}$ [kN] – Minimum shear resistance component contributed by the concrete slab per concrete rib (rib spacing b = 750 mm)

	Thickness of concrete slab h_c	Concrete strength class					
		C20/25	C25/30	C30/37	C35/45	C40/50	C45/55
$V_{Rd,c,min}$ [kN]	8 cm	10.1	11.3	12.3	13.3	14.2	15.1
	9 cm	10.3	11.6	12.7	13.7	14.6	15.5
	10 cm	10.6	11.8	13.0	14.0	15.0	15.9

Table 4: $V_{Rd,s}$ [kN] – Shear resistance component contributed by the double-shear inclined stirrups in accordance with Annexes 7 to 9 per rib **at the intermediate support** (rib spacing b = 750 mm)

	Reinforcement diameter ϕ [mm]				
	6	7	8	9	10
$V_{Rd,s}$ [kN]	17.4	23.6	31.0	39.1	48.3

Table 5: $V_{Rd,s}$ [kN] – Shear resistance component contributed by the double-shear inclined stirrups in accordance with Annexes 7 to 9 per rib **at the end support** (rib spacing b = 750 mm)

	Concrete strength class	Reinforcement diameter ϕ [mm]				
		6	7	8	9	10
$V_{Rd,s}$ [kN]	C20/25	8.6	10.1	11.5	13.0	14.4
	C25/30	10.0	11.7	13.4	15.0	16.7
	C30/37	11.3	13.2	15.1	17.0	18.9
	C35/45	12.5	14.6	16.7	18.8	20.9
	C40/50	13.0	16.0	18.3	20.6	22.8
	C45/55	13.0	17.3	19.8	22.2	24.7

Table 6: $V_{Rd,K}$ [kN] – Shear resistance component contributed by the profiled steel sheeting per rib (resistance per pair of cleats and/or rib)

	Nominal thickness of the profiled steel sheets t_{nom} [mm]			
	1.00	1.13	1.25	1.50
$V_{Rd,K}$ [kN]	13.5	16.2	19.0	25.2

2.2.5.3.3 Shear resistance verification for the ribbed reinforced concrete slab outside the support area

Outside the support area, the shear resistance of the ribbed reinforced concrete slab shall be verified without taking the contribution of the profiled steel sheeting into account. The design shear force $V_{c,rib,Ed}$ in accordance with Annex 11 acting on the ribbed reinforced concrete slab outside the support area shall not exceed the design shear resistance $V_{Rd,c}$ in accordance with DIN EN 1992-1-1[1] / DIN EN 1992-1-1/NA[2], Clause 6.2.2(1). The smallest cross-section width b_w shall be assumed to be the rib width at the height of the longitudinal reinforcement (see Annex 6).

2.2.5.3.4 Anchoring of the longitudinal rib reinforcement and support reinforcement by lap joint

Verification of the anchoring of the longitudinal rib reinforcement and the support reinforcement (inclined stirrup in accordance with Annexes 7 to 9 or supporting reinforcement in accordance with Annexes 17 and 18) shall be provided by verifying the lap length of the aforementioned reinforcements in accordance with DIN EN 1992-1-1[1] / DIN EN 1992-1-1/NA[2] Clause 8.7.3 for the full tensile force of the supporting reinforcement.

2.2.5.3.5 Design of the supporting beams as steel composite beams

2.2.5.3.5.1 Use of cleats as connectors (non-ductile)

The steel cleats welded to the upper flange of the steel beam shall be considered as non-ductile shear connector in accordance with DIN EN 1994-1-1[19]. Where the use of steel cleats as shear connector is provided for in the design, the steel composite beam of the Hoesch Additive Floor® shall be verified using the design diagrams given in Annex 13. The maximum longitudinal shear force $V_{L,Ed,max}$ within the beam length can be read from the diagram as a function of the utilisation factor of the bending moment stress η_M. Alternatively, it can be determined using equations (9) to (12).

$$\eta_M = \frac{M_{Ed}}{M_{pl,Rd}} \qquad (8)$$

where:

M_{Ed} is the design bending moment from external loads

$M_{pl,Rd}$ is the design plastic bending moment resistance of the composite section in accordance with DIN EN 1994-1-1[19]

The maximum longitudinal shear force for un-propped beams (i.e. beams without a dead-weight composite) shall be

$$V_{L,Ed,max} = V_{L,Ed,A} \quad \text{for } \eta_M \leq 0.75 \qquad (9)$$

$$V_{L,Ed,max} = V_{L,Ed,A} \cdot \left(1 + 7{,}5 \cdot \left(\frac{M_{Ed}}{M_{pl,Rd}} - 0{,}75\right)\right) \quad \text{for } 0.75 < \eta_M \leq 0.95 \qquad (10)$$

and for propped composite beams (i.e. beams with a dead-weight composite)

$$V_{L,Ed,max} = V_{L,Ed,A} \quad \text{for } \eta_M \leq 0.95 \qquad (11)$$

$$V_{L,Ed,max} = V_{L,Ed,A} \cdot \left(1 + 3{,}0 \cdot \left(\frac{M_{Ed}}{M_{pl,Rd}} - 0{,}95\right)\right) \quad \text{for } 0.95 < \eta_M \leq 1.00 \qquad (12)$$

where $V_{L,Ed,A}$ is the design longitudinal shear force at the support in accordance with equation (13) for un-propped beams. For propped beams, the longitudinal shear force at the support may be determined in consideration of creep and shrinkage as well as the sequence of construction.

$$V_{L,Ed,A} = \frac{A_{c,0} \cdot z_{ic,0}}{I_{i,0}} \cdot V_{c,Ed} \quad [\text{kN/m}] \qquad (13)$$

where:

$A_{c,0}$ is the reduced concrete cross-sectional area of the composite cross-section at time t = 0, related to the modulus of elasticity of the structural steel

$z_{ic,0}$ is the distance of the ideal centre of the composite section from the centre of the concrete area at time t = 0

$I_{i,0}$ is the ideal inertia moment of the composite section at t = 0

$V_{c,Ed}$ is the component of the shear force acting on the composite section at the support

It shall be verified that the maximum longitudinal shear stress at the interface does not exceed the longitudinal shear resistance of the cleats.

$$V_{L,Ed,max} \leq V_{L,Rd} \qquad (14)$$

For the longitudinal shear resistance of the cleats, the shear at the level of the upper edge of the cleat shall always be decisive provided that the design boundary conditions in accordance with Annex 14 are met. It is therefore not necessary to verify the resistance of the pure cleat cross-section, the welded joints for fastening to the steel beam flange and the partial surface pressure of the concrete immediately upstream from the cleat.

With a given spacing of the ribs of 750 mm and an arrangement of 2 cleats per rib, the longitudinal shear resistance of the cleats shall be calculated using equation (15) from the resistance per cleat

$$V_{L,Rd} = \frac{n}{e} \cdot P_{Rd} = \frac{P_{Rd}}{0{,}375} \qquad (15)$$

where:

n = 2, number of cleats per support

e = 0.75 m, average distance between pairs of cleats in the longitudinal direction of the beam

P_{Rd} is the design longitudinal shear resistance of one cleat in accordance with equation (16)

$$P_{Rd} = P_{Rd,c} + P_{Rd,s} \tag{16}$$

$P_{Rd,c}$ is the longitudinal shear resistance component contributed by the tensile strength of the concrete in relation to one cleat in accordance with Table 7

$P_{Rd,s}$ is the longitudinal shear resistance component contributed by the reinforcement (reinforcement loops) crossing the shear interface in relation to one cleat in accordance with Table 8

Table 7: $P_{Rd,c}$ [kN] – Longitudinal shear resistance component contributed by the tensile strength of the concrete in relation to one cleat

Flange width b_f [mm]	Concrete strength class					
	C20/25	C25/30	C30/37	C35/45	C40/50	C45/55
200	103.2	119.7	135.2	149.8	163.7	177.1
250	112.8	130.9	147.8	163.8	179.1	193.7
300	122.5	142.1	160.5	177.9	194.4	210.3

Table 8: $P_{Rd,s}$ [kN] – Design longitudinal shear resistance component contributed by the reinforcement (reinforcement loop) crossing the shear interface, per pair of cleats / support point

Diameter $\phi_{s,st}$ of the reinforcement loop in the cleats [mm]	6	8	10
$P_{Rd,s}$ [kN]	20.9	37.2	58.1

Alternatively, it is also possible to use tension anchors instead of an arrangement of reinforcement loops to join the shear interface. Stud shear connectors in accordance with DIN EN ISO 13918[22] with small diameters $d_Z \leq 13$ mm may be used as tension anchors. If the design provides for the arrangement of one tension anchor in the centre between 2 steel cleats, the resistance components in accordance with Table 9 shall apply. In this case, the resistance component $P_{Rd,s}$ in equation (16) shall be replaced by the component $P_{Rd,Z}$.

Table 9: Design longitudinal shear resistance component contributed by the tension anchors $P_{Rd,Z}$ [kN] crossing the shear interface per cleat

Diameter d_Z of the tension anchors [mm]	10	13
$P_{Rd,Z}$ [kN]	7.0	11.8

Factoring in the un-propped composite beam in a plastic state exceeding $0.95 \cdot M_{pl}$ is not permitted.

22 DIN EN ISO 13918:2018-04 Welding – Studs and ceramic ferrules for arc stud welding (ISO 13918:2017)

2.2.5.3.5.2 Use of ductile shear connectors for transferring longitudinal shear forces

If the design provides for ductile shear connectors in accordance with DIN EN 1994-1-1[19] to be used for the transfer of longitudinal shear forces, a joint longitudinal shear action with the steel cleats shall be prevented by elastic cushioning of the vertical contact surfaces of the steel cleats. The design of the elastic cushioning shall be in accordance with Annex 16. The elastic material shall have a minimum ductility of 4 mm at a pressure of 2 N/mm². Stud shear connectors in accordance with DIN EN ISO 13918[22] may be used as ductile shear connectors. Design shall be in accordance with DIN EN 1994-1-1[19].

The application of Clause 6.6.5.1 of DIN EN 1994-1-1[10] for separation resistance of the slab used as the flange of the beam can be waived, if the concrete thickness above the profiled steel sheeting does not exceed 12 cm.

2.2.5.3.6 Verification of the concrete slab as the flange of steel composite beams

If the slab is used as the flange of a composite steel beam, the connection of the concrete flange shall be verified. The design value to be used for the verification of the shear connector shall be considered as the design value of the acting longitudinal shear force $V_{L,Ed.}$

The longitudinal shear resistance $V_{L,Rd}$ in the slab cross-section shall be determined in accordance with DIN EN 1992-1-1[1] / DIN EN 1992-1-1/NA[2] Clause 6.2.4 or DIN EN 1994--1--1[19], Clause 6.6.6.2.

The anchoring of the transverse reinforcement shall be verified separately, especially in the case of edge beams.

2.2.5.3.7 Safety in case of fire

2.2.5.3.7.1 General

Unless otherwise specified below, the Technical Building Rules shall apply to the fire safety verification of the Hoesch Additive Floor.

In accordance with Table 10, the regulatory requirements for fire safety shall be deemed to have been met for the Hoesch Additive Floor if the verifications of the stability and the integrity have been provided in accordance with Sections 2.2.5.3.7.2 to 2.2.5.3.7.3 for the required duration.

Table 10: Classification of compliance with regulatory requirements

Regulatory requirement	Stability and integrity under fire exposure verified for (in minutes)
fire-retardant	≥ 30
highly fire-retardant	≥ 60
fire-resistant	≥ 90

The supporting and, where applicable, adjacent separating elements (e.g., supports or connections, supporting beams, walls) shall meet the same fire resistance requirements as the slab itself.

2.2.5.3.7.2 Proof of stability under fire exposure

The fire resistance of the Hoesch Additive Floor shall be verified using only the resistance of the ribbed reinforced concrete slab in accordance with the following provisions. The effect of the profiled steel sheeting shall be disregarded for the purposes of the verification.

<u>Bending moment resistance in case of fire exposure from below</u>

The design flexural strength of the ribbed reinforced concrete slab in case of fire $M_{c,Rd,fi}$ per rib shall be:

$$M_{c,Rd,fi} = \frac{1}{\gamma_{M,fi}} A_s \, k_1 \, f_{sk} \left[d - 0{,}5 \frac{A_s \, k_1 \, f_{sk}}{0{,}85 \, f_{ck} \, b} \right] \qquad (17)$$

where:

$\gamma_{M,fi}$ partial safety factor $\gamma_{M,fi} = 1.0$

A_s cross-sectional area of the reinforcing steel per rib with $A_s \leq 5.0$ cm²,

f_{sk} characteristic yield strength of the reinforcing steel,

f_{ck} characteristic cylinder compressive strength of the concrete,

b rib spacing = 750 mm,

d effective height of the reinforced concrete rib,

k_1 factor in accordance with Table 11 to take into consideration the reduced yield strength of the reinforcing steel under fire exposure.

Table 11: Reduction factors k_1 in case of fire exposure from below

	Spacing *u* [mm] of the rib reinforcement from the bottom edge of the rib[1)]			
Fire resistance duration (for flexural strength)	40	50	60	70
≥ 30 minutes	1.00	1.00	1.00	1.00
≥ 60 minutes	0.95	1.00	1.00	1.00
≥ 90 minutes	0.45	0.60	0.70	0.80

1) Linear interpolation may be used for intermediate values of *u*.

<u>Shear resistance in case of fire exposure from below</u>

The profiled steel sheeting supported on the steel cleat shall be disregarded in the calculation for the transfer of shear forces in the event of fire exposure. The total shear resistance of the slab shall be verified via the reinforced concrete ribs and a fire-protective supporting reinforcement in accordance with Annexes 17 and 18. The support reinforcement in accordance with Annexes 7, 8 and 9 may be omitted in this case.

The design shear resistance of the fire-protective supporting reinforcement $V_{c,Rd,fi}$ per rib shall be equal to the lower one of the following two values:

$$V_{c,Rd,fi} = \frac{1}{\gamma_{M,fi}} A_{s,H}\, k_2\, f_{sk}\; 0{,}85\, h_c / a \qquad (18)$$

$$V_{c,Rd,fi} = \frac{1}{\gamma_{M,fi}} A_{s,V}\, k_3\, f_{sk} \qquad (19)$$

where:

$\gamma_{M,fi}$ partial safety factor $\gamma_{M,fi} = 1.0$

$A_{s,H}$ cross-sectional area of the horizontal supporting reinforcement in accordance with Annexes 17 and 18,

$A_{s,V}$ cross-sectional area of the vertical supporting reinforcement in accordance with Annexes 17 and 18,

f_{sk} characteristic yield strength of the reinforcing steel,

h_c thickness of the concrete flange (concrete slab),

a distance of the centre line of the vertical supporting reinforcement from the system line of the support beam (see Annexes 17 and 18),

k_2, k_3 factors in accordance with Table 12 for accounting for the reduced yield strength of the reinforcing steel under fire exposure.

Table 12: Fire reduction factors k_2 and k_3

Fire resistance duration (for shear resistance)	k_2	k_3
≥ 30 minutes	1.00	1.00
≥ 60 minutes	0.80	0.60
≥ 90 minutes	0.50	0.30

2.2.5.3.7.3 Verification of integrity under fire exposure

The integrity may be verified taking into account the profiled steel sheeting, in the same way as for composite slabs, in accordance with DIN EN 1994-1-2 in conjunction with DIN EN 1994-1-2/NA for criteria E and I.

Integrity verification (criteria E and I) for the slabs shall be provided for the duration specified in Table 10.

2.2.5.3.7.4 Verifications for fire exposure from above

Stability and integrity verification under fire exposure from above (fire attacking from top to bottom) may be verified accordingly taking Sections 2.2.5.3.7.1 to 2.2.5.3.7.3 into account.

2.2.5.4 Serviceability limit state verifications

2.2.5.4.1 Crack width control for the ribbed reinforced concrete slab

To ensure the durability of the structure, especially in the area of cracks, the specifications set out in DIN EN 1992-1-1[1] / DIN EN 1992-1-1/NA[2] shall be observed.

Crack width control shall be verified out in accordance with DIN EN 1992-1-1[1] / DIN EN 1992-1-1/NA[2], Clause 7.3.

Where the slab is also the flange of a composite beam (see Section 2.2.5.3.5), the resulting total reinforcement shall be determined using the following equations. The higher one of these values shall be decisive.

$$\text{erf } a_s = a_{s,Riss} + 0.5\, a_{s,T}$$

$$\text{erf } a_s = a_{s,T}$$

where, $a_{s,Riss}$ is the required minimum reinforcement in accordance with DIN EN 1992-1-1[1] / DIN EN 1992-1-1/NA[2], Clause 7.3, and $a_{s,T}$ is the required transverse reinforcement resulting from the verification of the longitudinal shear resistance (shoulder shear reinforcement) in accordance with Section 2.2.5.3.6.

When using a non-corrosive reinforcement, its national technical approval and/or general construction technique permit shall apply.

2.2.5.4.2 Deflection control

To limit deflection, the specifications set out in DIN EN 1992-1-1[1] / DIN EN 1992-1-1/NA[2], Clause 7.4 may be applied.

2.3 Execution

Concrete work shall be subject to DIN EN 13670[23] and DIN 1045-3[24].

Depending on the design requirements of the project, the specifications set out in DIN EN 1090-2[6] shall apply to the execution of welded joints on the construction site, in agreement with the responsible designer and the authority having issued the building permit.

After positioning, each profiled steel sheet shall be fastened to the cleats in accordance with the execution documentation using power-actuated fasteners in accordance with Annexes 3, 4 and 5 or other suitable connectors covered by a national technical approval or an ETA.

[23] DIN EN 13670:2011-03 Execution of concrete structures
[24] DIN 1045-3:2012-03 Concrete, reinforced and prestressed concrete structures – Part 3: Execution of structures – Application rules for DIN EN 13670

The profiled steel sheets shall be fastened along the longitudinal joints and the longitudinal edge with suitable connectors covered by a national technical approval or an ETA with a maximum spacing of 666 mm. If the profiled steel sheeting is used as a diaphragm (in-plane stiffness effect), the number and arrangement of the connectors shall be verified by means of structural analysis.

If the profiled steel sheeting is used for bracing or to resist horizontal loads during construction, it shall only be installed by steel construction specialists under the supervision of a specialised engineer. An acceptance report on the proper and functional execution shall be drawn up and counter-signed by the responsible specialised engineer or specialised construction supervisor. The acceptance report shall be added to the technical documentation and presented to the building authorities upon request.

Low-shrinkage concrete, i.e. concrete with a low water/cement ratio, shall be used.

When concreting in sections, it shall be ensured that that no significant constraints occur in the slab section that is still curing due to different deformations of the support beams.

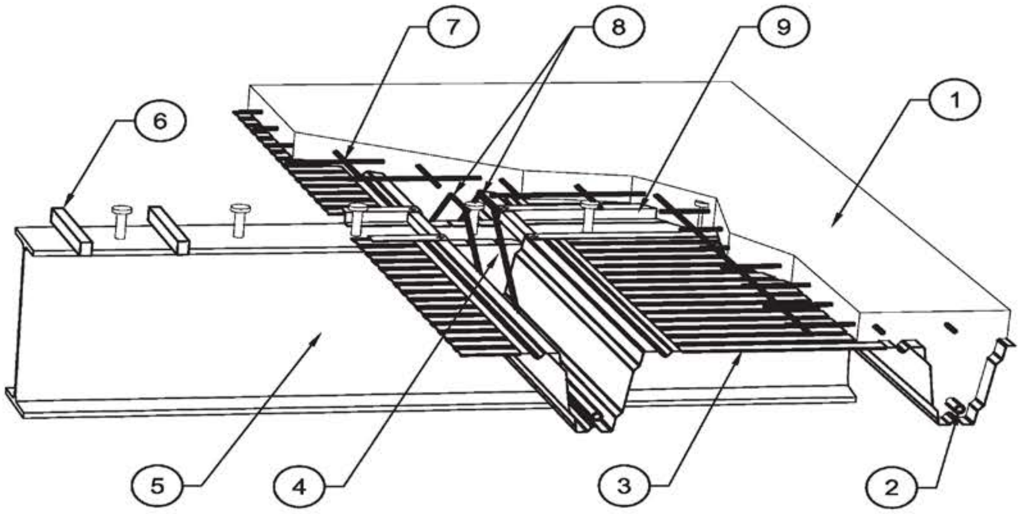
It shall be ensured that concrete accumulations exceeding the design weight limits for the construction stage in accordance with Section 2.2.4.1 are avoided.

When sheet metal parts are used to come to a continuous slab, care shall be taken during concreting that the areas of the sheet metal parts are completely filled with concrete which is carefully compacted.

The executing company shall provide a declaration of conformity in accordance with Section 16(a)(5) and Section 21(2) of the German Model Building Code to confirm the conformity of the Hoesch Additive Floor® with the general construction technique permit included in this decision.

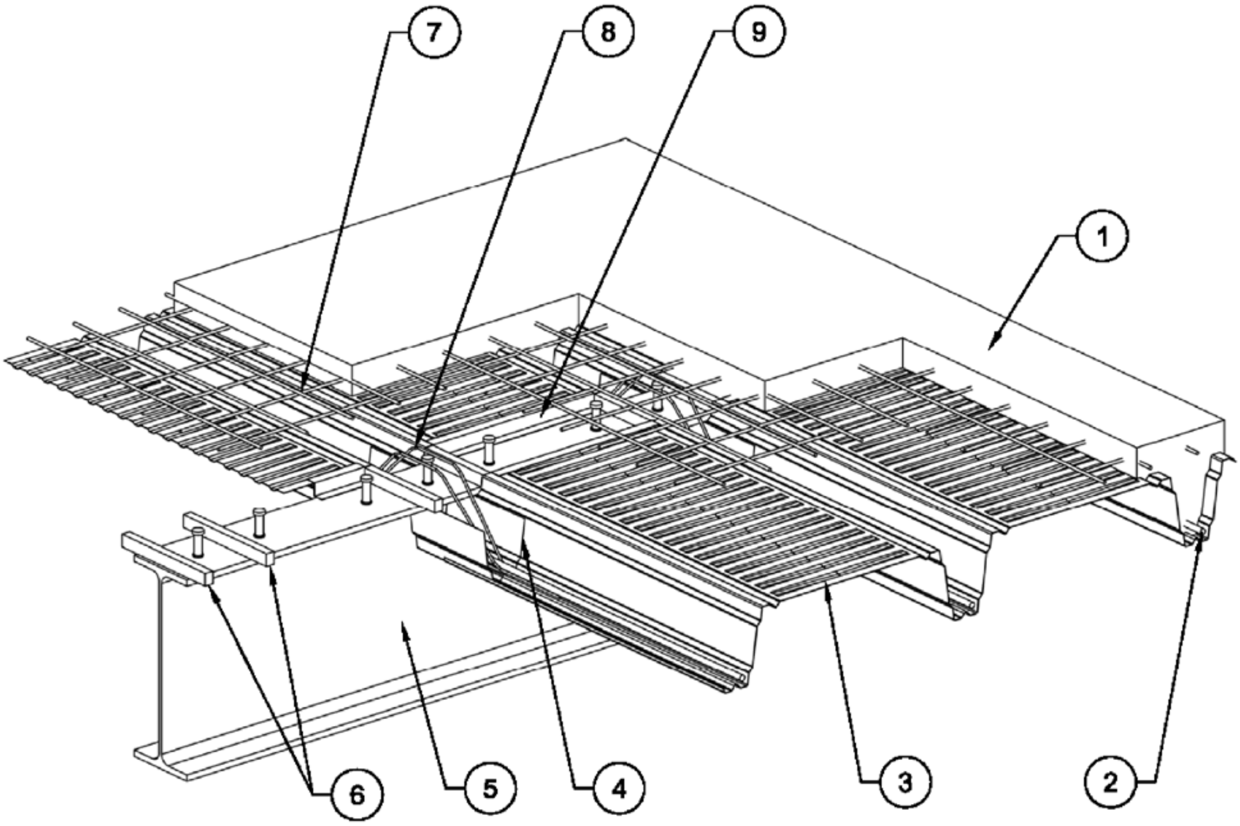
Dr.-Ing. Ronald Schwuchow
Head of Section

Drawn up by
Bertram



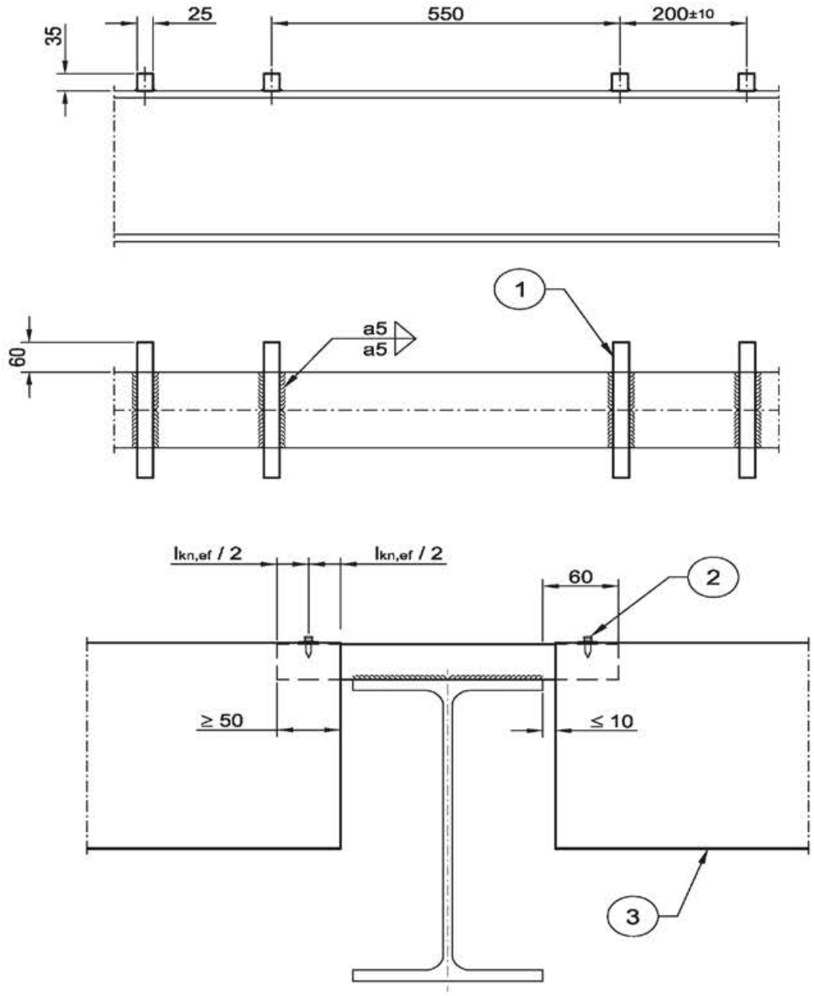
1 Concrete
2 Rib reinforcement
3 Trapezoidal steel sheeting
4 Cap (plastic)
5 Composite steel beam
6 Support cleats (steel)
7 Slab reinforcement
8 Structurally required support reinforcement
9 Z-profile (profiled steel sheet)

Hoesch Additive Floor®	**Annex 1**
System overview of the 'chain of single-span beams' design variant	



1 Concrete
2 Rib reinforcement
3 Trapezoidal steel sheeting
4 Sheet metal part (dimensions deposited with DIBt)
5 Composite steel beam
6 Support cleats (steel)
7 Slab reinforcement
8 Structurally required support reinforcement
9 Z-profile (profiled steel sheet)

Hoesch Additive Floor®	**Annex 2**
System overview of the 'continuous beam' design variant	



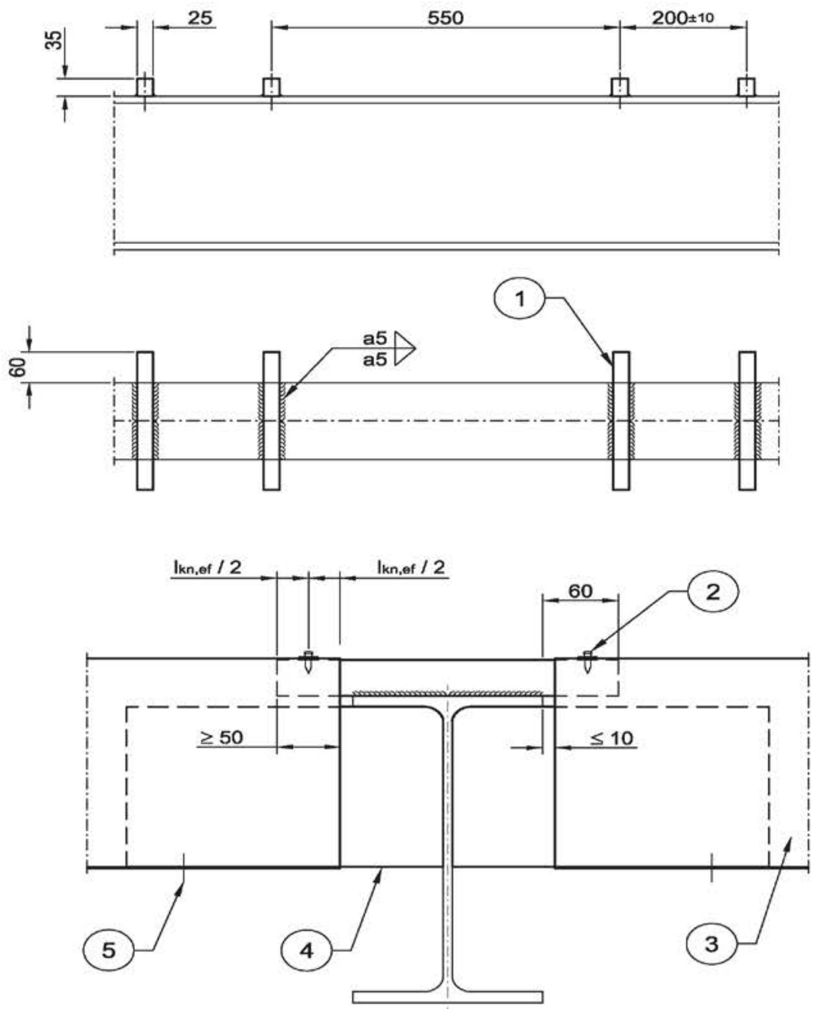
1 Steel cleat S 235
2 Power-actuated fastener (with regulatory approval)
3 Trapezoidal steel sheeting TRP 200

All dimensions in [mm]

Hoesch Additive Floor®

Support cleats at the intermediate support
of the 'chain of single-span beams' design variant

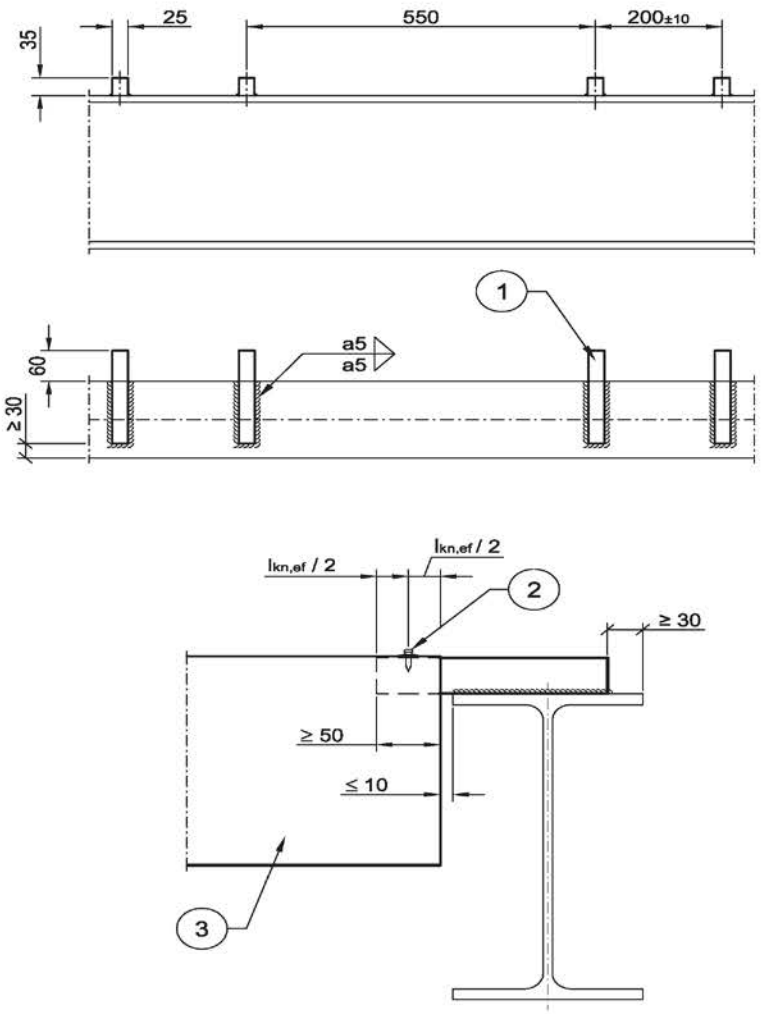
Annex 3



1 Steel cleat S 235
2 Power-actuated fastener (with regulatory approval)
3 Trapezoidal steel sheet TRP 200
4 Sheet metal part
5 Fastener (with regulatory approval)

All dimensions in [mm]

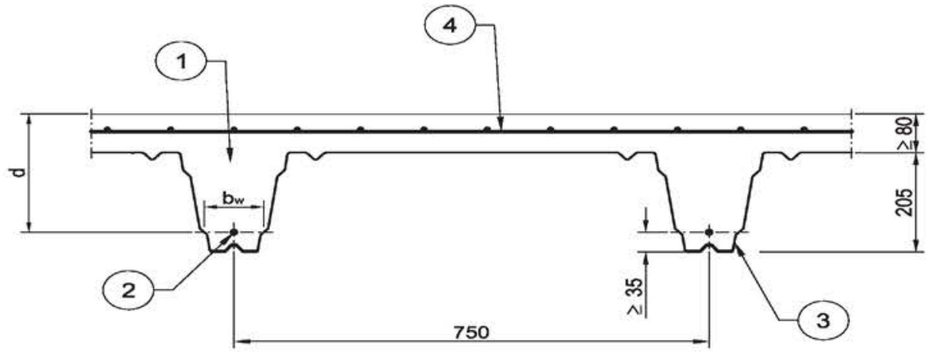
Hoesch Additive Floor®	**Annex 4**
Support cleats at the intermediate support of the 'continuous beam' design variant	



1 Steel cleat S 235
2 Power-actuated fastener (with regulatory approval)
3 Trapezoidal steel sheet TRP 200

All dimensions in [mm]

Hoesch Additive Floor®	**Annex 5**
Support cleat at end support	



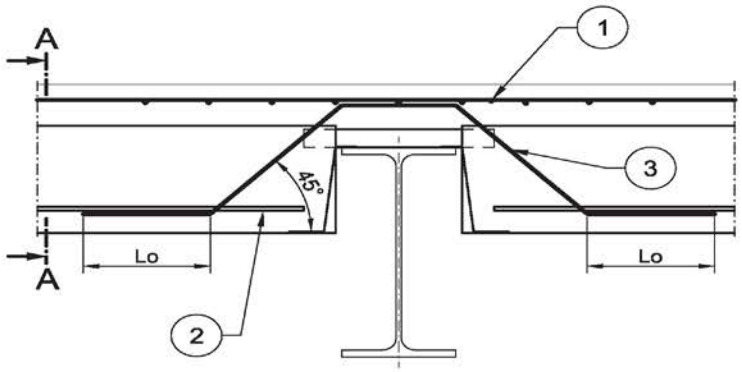
1 Concrete
2 Rib reinforcement
3 Trapezoidal steel sheet TRP 200
4 Slab reinforcement

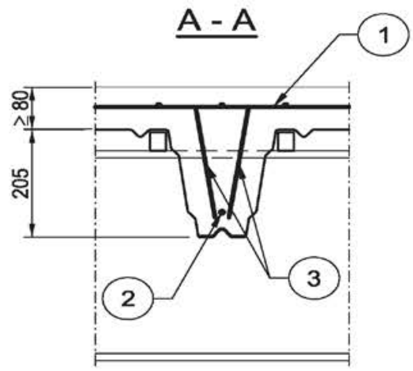
All dimensions in [mm]

Hoesch Additive Floor®

Slab cross-section

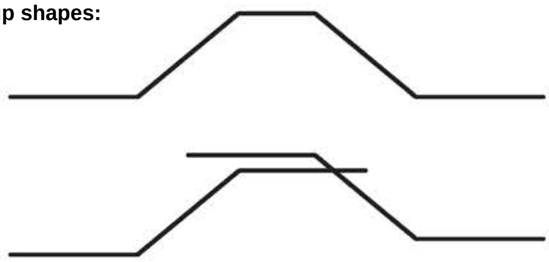
Annex 6





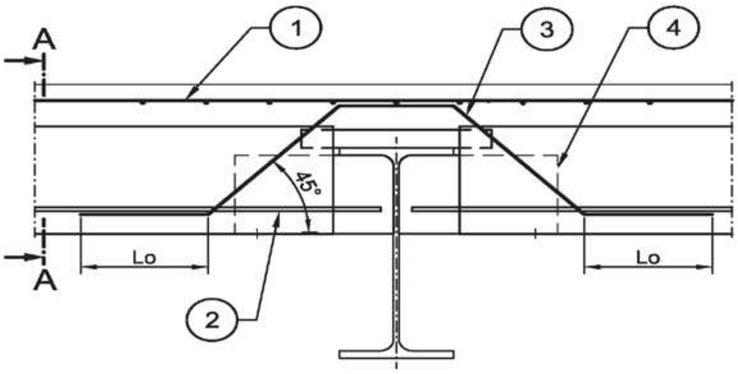
1 As, $_{slab}$
2 As, rib
3 As, $_{stirrup}$ **(at least 2 stirrups Ø6)**
L_o lap length in accordance with DIN EN 1992-1-1

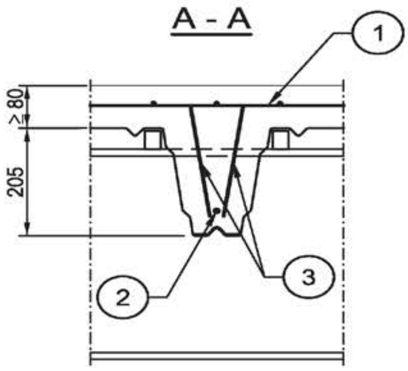
Possible stirrup shapes:



All dimensions in [mm]

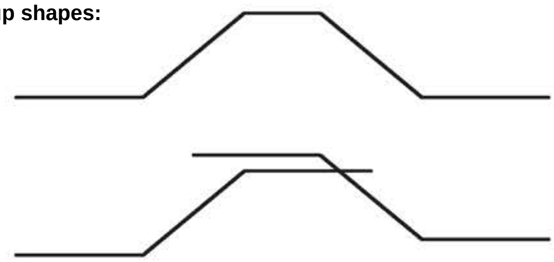
Hoesch Additive Floor®	**Annex 7**
Structurally required reinforcement at the intermediate support of the 'chain of single-span beams' design variant	





1 As, slab
2 As, rib
3 As, stirrup **(at least 2 stirrups Ø6)**
4 Sheet metal part
L_o lap length in accordance with DIN EN 1992-1-1

Possible stirrup shapes:

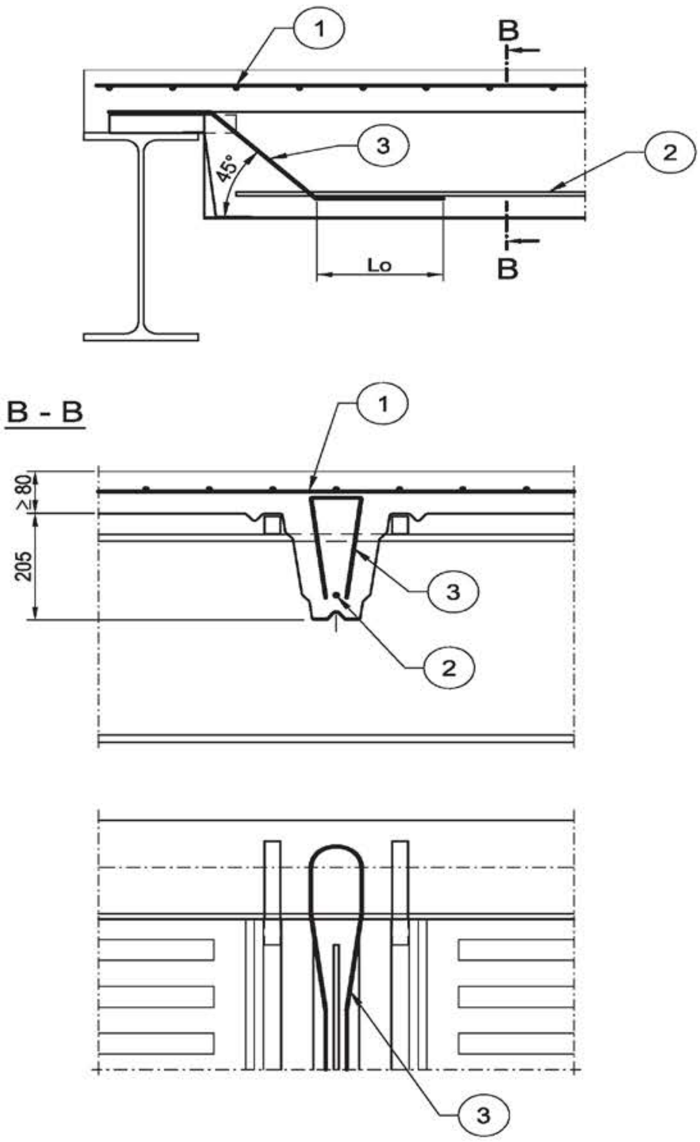


All dimensions in [mm]

Hoesch Additive Floor®

Structurally required reinforcement at the intermediate support
of the 'continuous beam' design variant

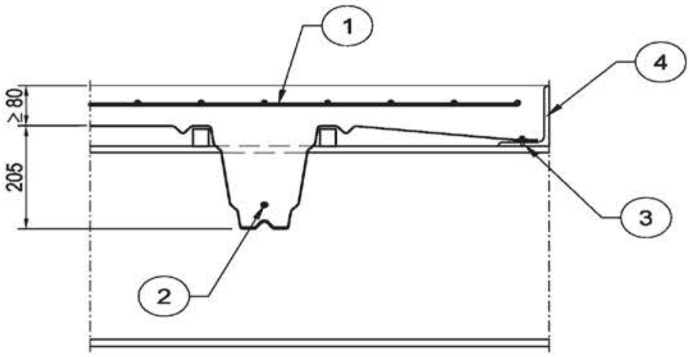
Annex 8



1 As, **slab**
2 As, rib
3 As, stirrup (1 stirrup Ø6)
L_o lap length in accordance with DIN EN 1992-1-1

All dimensions in [mm]

Hoesch Additive Floor®	**Annex 9**
Structurally required reinforcement at the end support of the 'chain of single-span beams' design variant	



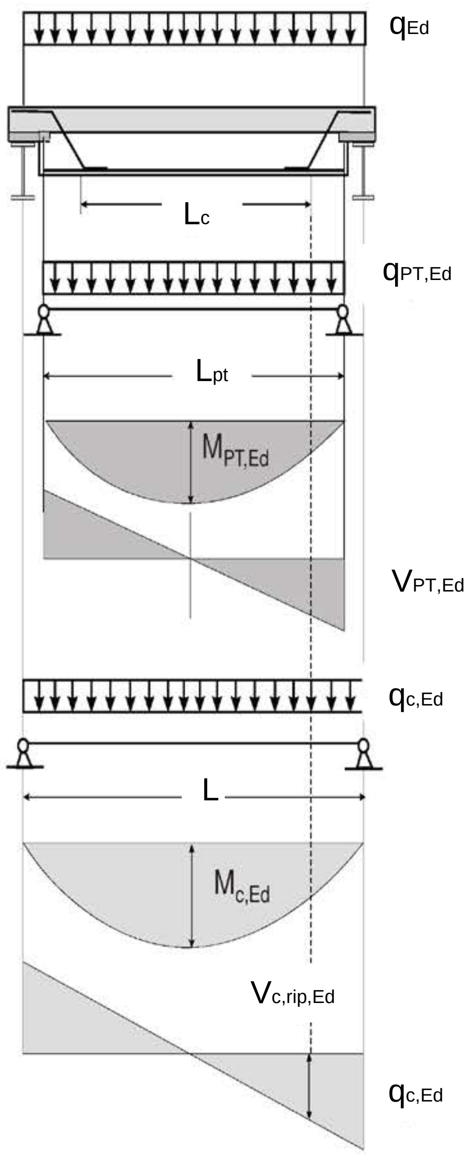
1 As, slab
2 As, rib
3 Power-actuated fastener (with regulatory approval)
4 Edge profile

All dimensions in [mm]

Hoesch Additive Floor®

Edge design

Annex 10



Hoesch Additive Floor®

Calculation model for shear resistance verification

Annex 11

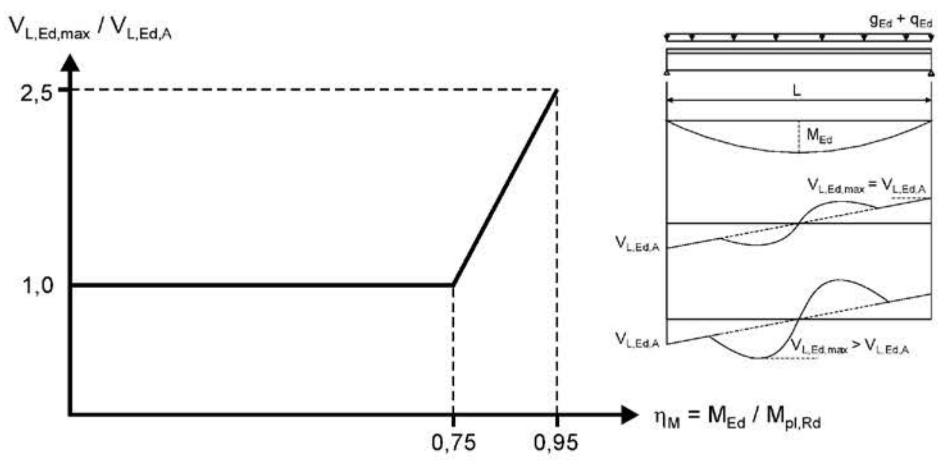
Table 1: Cross-sectional values and characteristic resistance values of the profile sheets
(a comma is used as the decimal marker)

Cross-sectional values			Characteristic moment resistance
Nominal sheet thickness	Self-weight	Inertia moment	Downward, evenly distributed load
t_{nom}	g	I_{ef}	$M_{PT,Rk}$
[mm]	[kN/m²]	[cm⁴/m]	[kNm/m]
1,00	0,128	653	17,0
1,13	0,145	758	19,9
1,25	0,160	855	22,1
1,50	0,192	1030	26,5

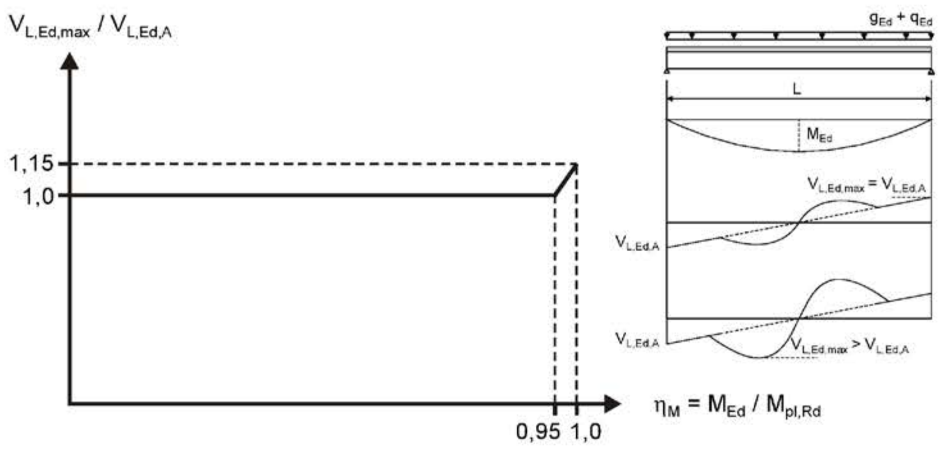
Hoesch Additive Floor®

Cross-sectional values and characteristic resistance values of the profile sheets

Annex 12

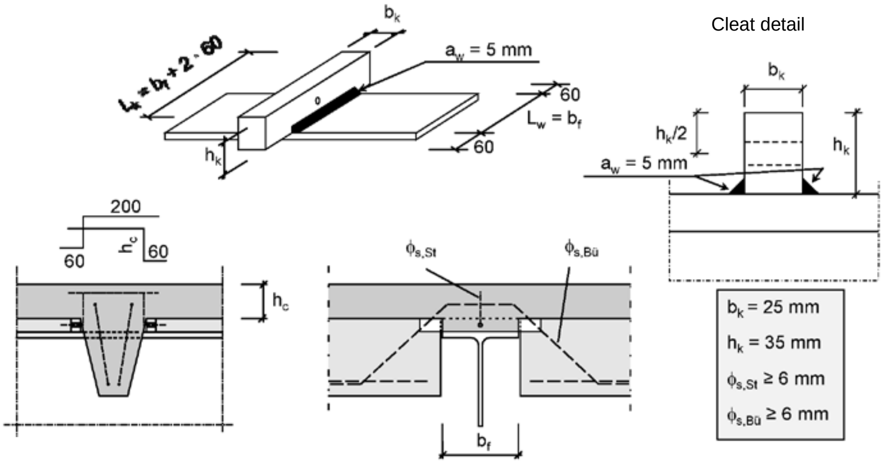


Design diagram for determining the maximum longitudinal shear force in the case of non-linear design of the steel composite beam without dead weight composite for the Hoesch Additive Floor®



Design diagram for determining the maximum longitudinal shear force in the case of non-linear design of the steel composite beam with a dead weight composite for the Hoesch Additive Floor®

Hoesch Additive Floor®	**Annex 13**
Diagrams for non-linear design of the composite steel beam	



Boundary conditions for the execution of the cleats

Longitudinal shear resistance:

$$V_{L,Rd} = \frac{n}{e} \cdot P_{Rd}$$

where $= P_{Rd,c} + P_{Rd,s}$ Longitudinal shear resistance per cleat

n = 2 Number of cleats per reinforced concrete rib

e = 0,75 m Spacing of reinforced concrete ribs

Table 1: Component of the design longitudinal shear resistance contributed by the the concrete $P_{Rd,c}$ [kN] per cleat
(a comma is used as the decimal marker)

Flange width b_f [mm]	Concrete strength					
	C 20/25	C 25/30	C 30/37	C 35/45	C 40/50	C 45/55
200	103,2	119,7	135,2	149,8	163,7	177,1
250	112,8	130,9	147,8	163,8	179,1	193,7
300	122,5	142,1	160,5	177,9	194,4	210,3

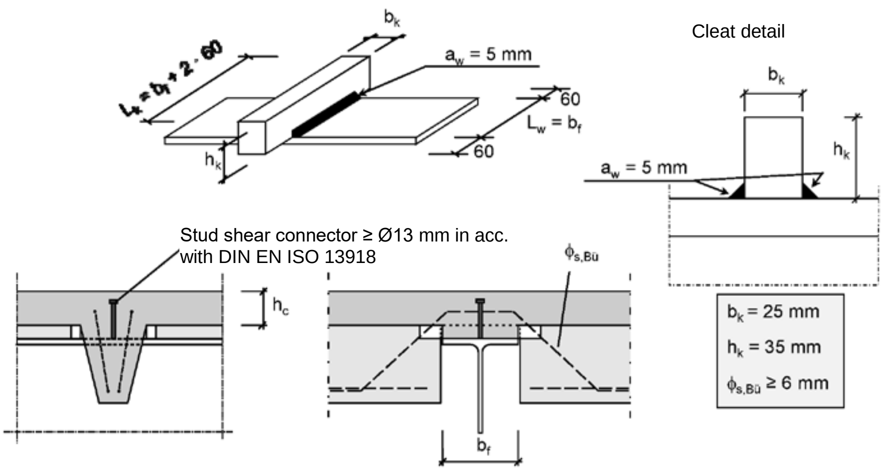
Table 2: Component of the design longitudinal shear resistance contributed by the reinforcement $P_{Rd,s}$ [kN] crossing the shear interface per cleat
(a comma is used as the decimal marker)

Diameter Øs,st of reinforcement loops in cleats [mm]	6	8	10
$P_{Rd,s}$ [kN]	10,4	18,6	29,0

Hoesch Additive Floor®

Longitudinal shear resistance in the shear interface of the composite steel beams when using stirrups

Annex 14



Boundary conditions for the execution of the cleats

Longitudinal shear resistance:

$$V_{L,Rd} = \frac{n}{e} \cdot P_{Rd}$$

where $P_{Rd} = P_{Rd,c} + P_{Rd,Z}$ Longitudinal shear resistance per cleat

n = 2 Number of cleats per reinforced concrete rib
e = 0,75 m Spacing of reinforced concrete ribs

Table 1: Component of the design longitudinal shear resistance contributed by the concrete $P_{Rd,c}$ [kN] per cleat
(a comma is used as the decimal marker)

Flange width b_f [mm]	Concrete strength					
	C 20/25	C 25/30	C 30/37	C 35/45	C 40/50	C 45/55
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250	112,8	130,9	147,8	163,8	179,1	193,7
300	122,5	142,1	160,5	177,9	194,4	210,3

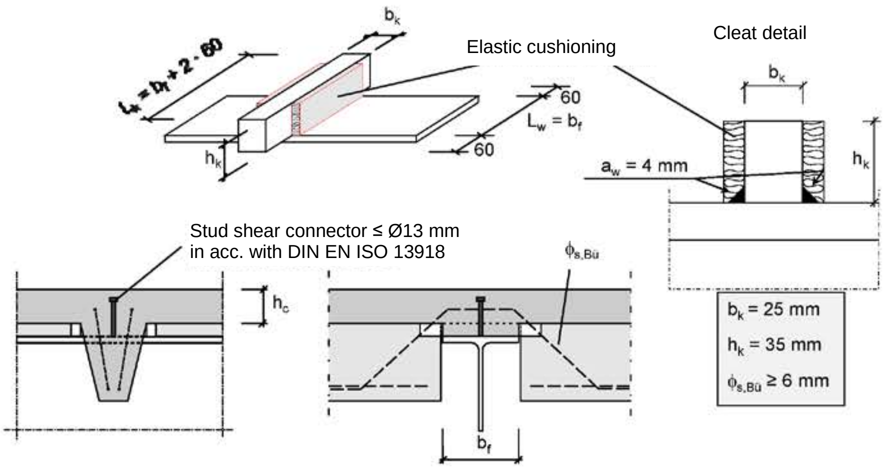
Table 2: Component of the design longitudinal shear resistance contributed by the tension anchors $P_{Rd,Z}$ [kN] crossing the shear interface per cleat
(a comma is used as the decimal marker)

Diameter d_z of the tension anchors	10	13
$P_{Rd,Z}$ [kN]	7,0	11,8

Hoesch Additive Floor®

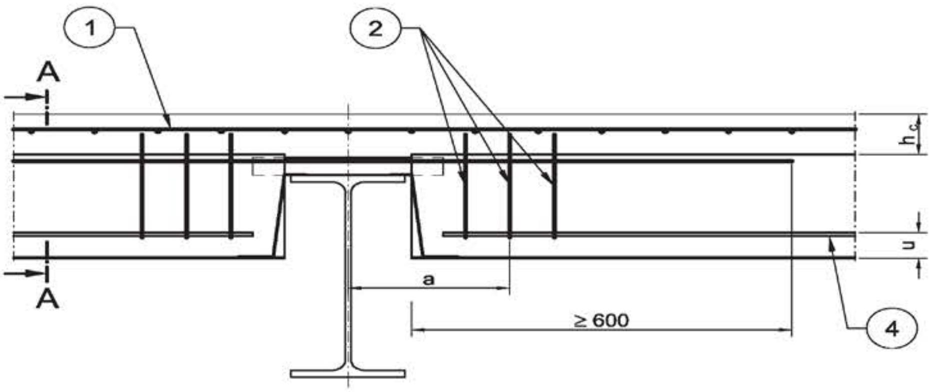
Longitudinal shear resistance in the shear interface of the composite steel beams when using tension anchors

Annex 15

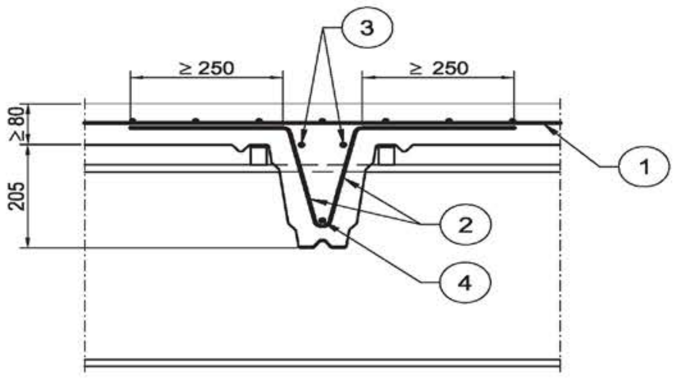


Elastic cushioning of cleats if the design provides for the use of ductile connectors

Hoesch Additive Floor®	**Annex 16**
Required cushioning of cleats if the design provides for the use of ductile stud shear connectors	



A - A



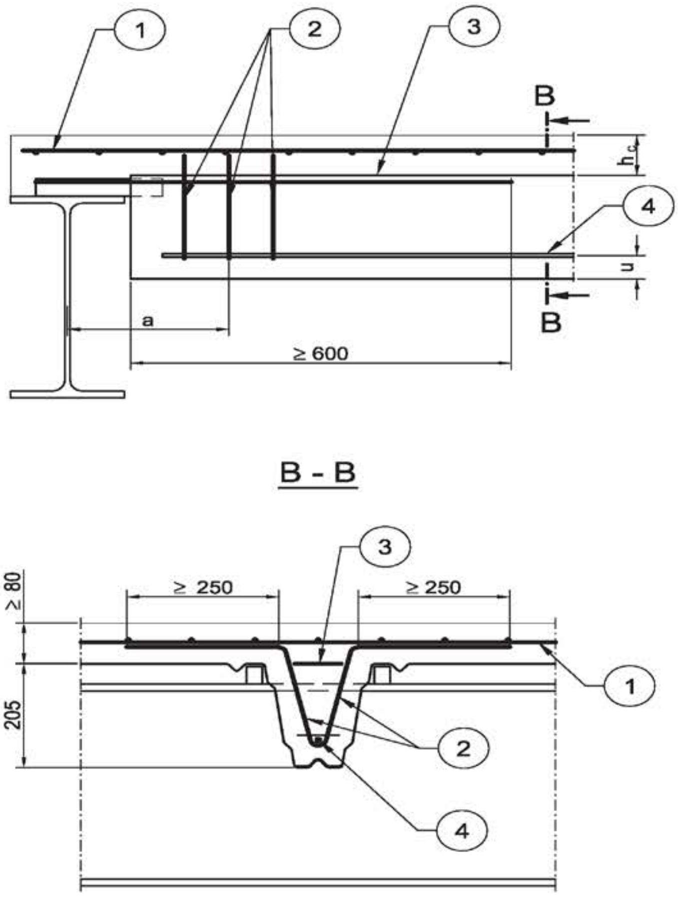
1 As, slab
2 **Vertical supporting reinforcement As.v in the form of a curved stirrup mesh**
3 **Horizontal supporting reinforcement As,H**
4 As, rib

All dimensions in [mm]

Hoesch Additive Floor®

Fire-protective supporting reinforcement at intermediate support

Annex 17



1 **As, slab**
2 **Vertical supporting reinforcement As.v in the form of a curved stirrup mesh**
3 **Horizontal supporting reinforcement As,H as a loop**
4 **As, rib**

All dimensions in [mm]

Hoesch Additive Floor®

Fire-protective supporting reinforcement at end support

Annex 18