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THERMOKORB® TKQ

THE LOAD-BEARING INSULATION ELEMENT FOR SHEAR LOADING

PATENTED

THERMOKORB® TKQ

The Thermokorb® TKQ is a heat-insulating, load-bearing connection element between building components made of reinforced concrete. It is used to improve the thermal insulation when connecting internal and external reinforced concrete components subject only to shear forces. Frequent areas of application are supported balcony slabs and access balconies, recessed balcony connections, platforms, etc.

Thermokorb® is a registered European Union trademark (no. 017792193).

Structure

The Thermokorb® TKQ consists of a structural framework of independent ribs and an 80 mm thick expanded polystyrene panel (EPS-W 30 according to standard ÖNORM EN 13163). The individual ribs penetrate the EPS panel and, in order to avoid corrosion, they consist of C-shaped stainless steel profiles with two vertical bars made of ribbed reinforcing steel welded to each of their ends.

Transfer of forces from the individual ribs to the adjacent reinforced concrete members occurs by restraining the profiles into the reinforced concrete member.

The single ribs are designed to resist both positive and negative shear forces. They consist of two 30 mm high C-shaped stainless steel profiles as well as ribbed reinforcing steel bars ø 10 mm (B550 according to ÖNORM B 4707) welded to the flanges of the profiles.

The Thermokorb® TKQ is suitable for a building component thickness from 16 cm. The individual ribs are manufactured using welding robots.

Cross sectional heights for a rib element	
Building component thickness (mm)	≥ 160
Rib height RH (mm)	110

Application

The Thermokorb® TKQ is designed exclusively for the transfer of shear forces and is particularly suitable for the connection of supported balconies and access balconies as well as recessed balconies and platforms.

Rib cages with a uniform rib spacing of 100 mm are intended for use in slab-shaped structures under shear loading (V_{Ed}). A Thermokorb® TKQ consists of at least one and a maximum of three ribs. Depending on the number of ribs, the element length is 100, 200 or 300 mm. Due to the compact design, no mounting bars are required. Therefore, the Thermokorb® TKQ can be inserted from the side into an already pre-tied reinforcement cage.

The rib geometry and the stainless steel C profiles are optimally matched to the mechanical requirements. The high rigidity ensures low vertical deformations even at high loads.

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The Thermokorb® TKQ is only available with a rib height of 110 mm. The forces that can be transmitted are therefore independent of the thickness of the connected members. In the case of high concentrated forces, consideration must be given to the application and transmission of the load.

Fire resistance

Without fire protection panels the Thermokorb® TKQ has a fire resistance classification of R60. For a higher level of fire protection (REI120), fire-proofing panels are arranged on the top and bottom. The lateral faces (open faces at the two ends of the thermal separation) of the REI120 fire protection version have to be carried out with fire proofing panels.

Properties of the Thermokorb® TKQ:

- The approximately double-symmetrical design ensures safe installation.
- 30kN shear load capacity per rib
- The small external dimensions allow for easy installation even in tight spaces.
- The Thermokorb® TKQ is available in the fire protection versions R60 and REI120.
- In case of high shear forces per unit of length, up to ten Thermokorb® TKQ ribs can be arranged side-by-side per metre.
- The Thermokorb® TKQ can be combined with the Thermokorb® types TKM, TKA and TDE.
- The reinforcement required on site is limited to four lock bars and to edge stirrups in the connected reinforced concrete components.

All information about the Thermokorb® TKQ is available at our website www.avi.at

CALCULATION SOFTWARE THERMOTOOL

The calculation software Thermotool enables the user to dimension all Thermokorb® types. The software consists of various modules that facilitate the calculation of thermal separations for common fields of application. The Thermotool software uses the finite element method to determine moments and shear forces. For the design, the relevant internal forces are determined individually for each Thermokorb.

Our design software is available for download on our website www.avi.at

TYPE SERIES: TKQ

Thermokorb® TKQ exclusively for shear force transfer

DESCRIPTION

The TKQ series is suitable for transferring shear forces for use with supported balconies and recessed balconies. The shear resistances of the Thermokorb® TKQ types are listed on page 5.

Main areas of application:

- Supported balconies and access balconies
- Recessed balconies

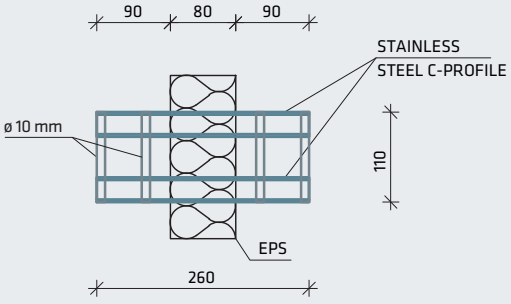


Fig. 1: Rib type of type series TKQ

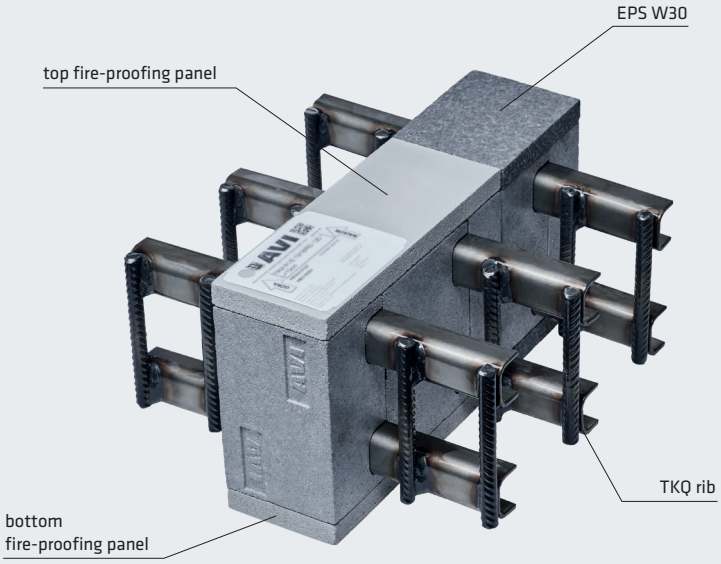


Fig. 2: TKQ examplary with/without fire-proofing panels

DESIGNATION SCHEME OF THE THERMOKORB® TKQ

Type/Rn RH/D (Note)

Type	Rib Design	Number of Ribs	Rib Height	BCT* or Insulation Height	Note
	R=element length depends on number of ribs	n	RH [cm]	D [cm]	Fire proofing: R60 or REI120
TKQ	R	1, 2, 3	11	16/18/20/22/24	R60/REI120

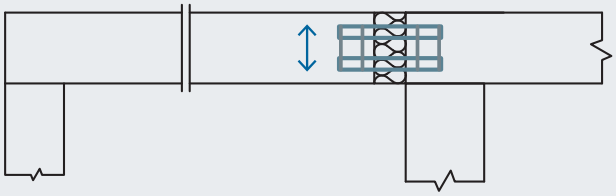
* Building Component Thickness

Examples: TKQ/R2 11/20 REI120
TKQ/R2 11/16 R60
TKQ/R1 11/24 R60
TKQ/R3 11/22 REI120

THERMOKORB® TKQ - STRUCTURAL BEHAVIOUR

The shear force is transferred via local bending of the individual profiles and is divided equally between the two profiles. The tensile and compressive forces from the offset moment (shear force × insulation thickness) are transferred to the reinforced concrete members via the welded-on vertical bars and the four lock bars required on site. Since no further moments from a global system behaviour can be transferred, the Thermokorb® TKQ represents a hinged connection. The system behaviour of all components results in the high shear capacity of the Thermokorb® TKQ rib.

Supported Balcony/Recessed Balcony
Thermokorb® TKQ to transfer positiv
and negative shear forces



SHEAR FORCE CAPACITY

The table below gives the Thermokorb® TKQ load-bearing capacity depending on the number of ribs. From 4 ribs, 2 Thermokorb® TKQ elements or more are arranged (see page 8).

BCT*	Rib height	Shear Resistance	Number of Ribs									
mm	mm		1	2	3	4	5	6	7	8	9	10
≥ 160	110	$V_{Rd,max}$ (kN)	30	60	90	120	150	180	210	240	270	300

* Building Component Thickness

The table below gives the maximum shear capacity of the slab per metre without shear reinforcement. The $V_{Rd,c}$ values were calculated with the concrete strength class C25/30 and the steel cross-section of the minimum bending reinforcement according to ÖNORM EN and B 1992-1-1.

		Slab Height [mm]					
		160	180	200	220	240	250
Minimum reinforcement present	mm^2/m	156	282	208	234	260	273
Shear resistance $V_{Rd,c}$ without shear reinforcement	kN/m	59.4	69.3	79.2	89.1	99.0	102.1

Due to the high shear resistance per rib, care must be taken to ensure adequate distribution in the slab. The sufficient design value of the shear resistance of the connected reinforced concrete members must be verified in the structural design according to EC2. The AVI Shear Reinforcing Element QE is particularly suitable for increasing the shear resistance (see also page 8).

ON-SITE REINFORCEMENT

An additional reinforcement ① for the transfer of the global offset moment (shear force V_{Ed} × insulation thickness t) is to be arranged in the reinforced concrete members. In order to be able to transmit both positive and negative shear forces and to allow the associated change of sign of the offset moment, this must be installed both at the top and bottom of the corresponding rib. Items ②, ④, ⑤ and ⑥ are to be provided in accordance with the general reinforcement rules for reinforced concrete members. For each rib, an edge stirrup ③ must be arranged next to the rib.

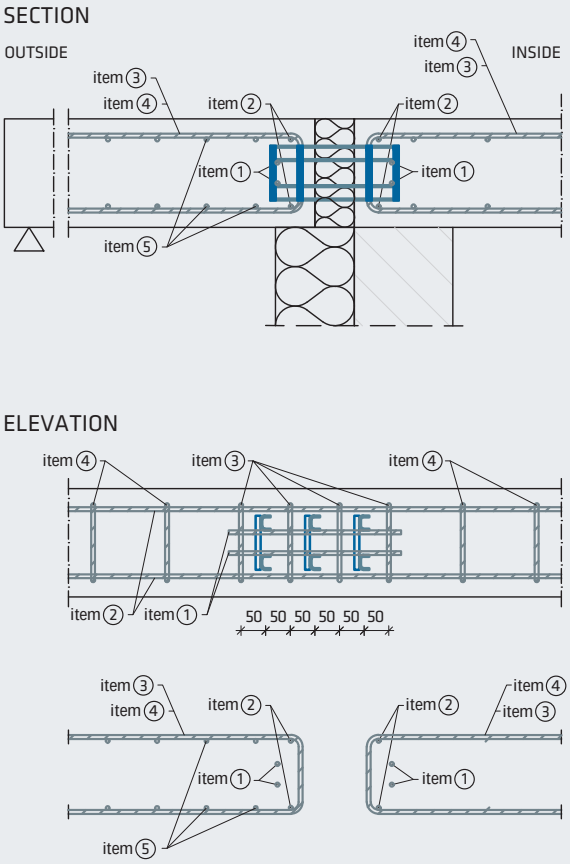


Fig. 3: On-site reinforcement with lock bars arranged on the outside

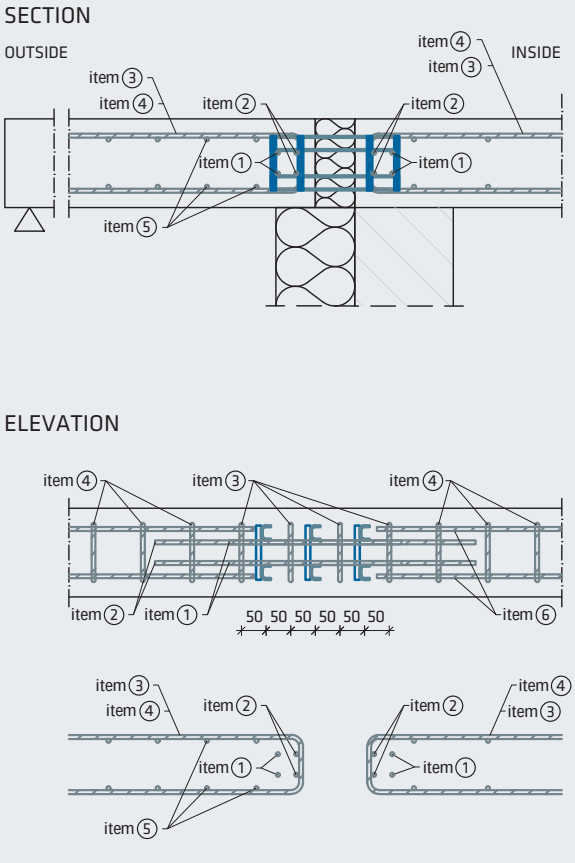
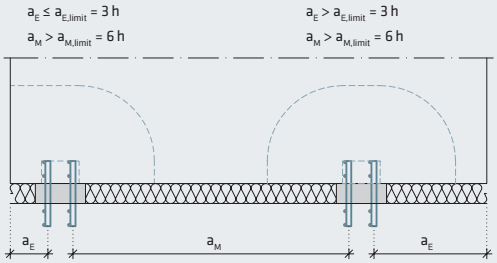


Fig. 4: On-site reinforcement with lock bars arranged on the inside for small slab thickness

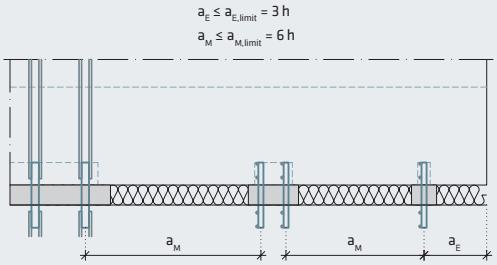
The following table shows the recommended minimum bending reinforcement for the TKQ types per layer to ensure the load is transferred into the reinforced concrete slab. These values correspond to a design according to Eurocode without additional punching shear or shear reinforcement. According to EC2, the associated reinforcement items must be anchored beyond the critical perimeter. The illustrations on page 7 show the associated perimeters.

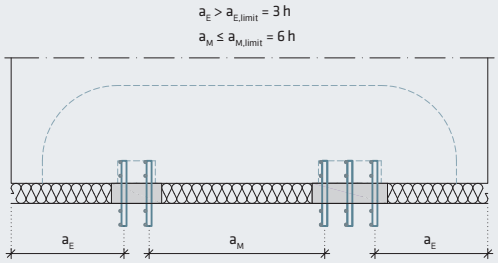
Structural measures such as shear reinforcement, punching shear reinforcement, creating an additionally reinforced strip in the slab, or a beam, or an inverted beam can result in better load transfer from the slab to the Thermokorb. The sufficient design resistance of the load transfer into the adjoining reinforced concrete member must be verified in the structural design according to EC2.

On-site reinforcement								
Lock bars								
item ①	to apply the tensile forces from the offset moment | ≥ ø8 | projection beyond the outermost ribs ≥ 50 mm							
item ②/⑥	acc. to general design rules | ø ≥ ø item ③ | arrangement in the corners of the edge stirrups or between the profiles							
U-stirrups at the edge								
item ③	for transferring the tensile forces from the offset moment | ≥ ø8 | right next to the ribs | minimum number = number of ribs + 1							
item ④	edge stirrups and longitudinal reinforcement acc. to general design rules							
Cross reinforcement								
item ⑤	cross reinforcement of the slab acc. to general design rules							
Recommended reinforcement for verification of load application (punching shear)								
Slab thickness		**Location**	**Type**	**160 mm**	**180 mm**	**200 mm**	**220 mm**	**240 mm**
∑ item ②/⑥ + ⑤ / ∑ item ③ + ④	[mm²/m]	centre	R1	251	251	251	251	251
				(ø8/200)	(ø8/200)	(ø8/200)	(ø8/200)	(ø8/200)
		centre	R2	503	251	251	251	251
				(ø8/100)	(ø8/200)	(ø8/200)	(ø8/200)	(ø8/200)
		centre	R3	1571	785	503	335	251
				(ø10/50)	(ø10/100)	(ø8/100)	(ø8/150)	(ø8/200)
		edge	R1	785	393	251	251	251
				(ø10/100)	(ø10/200)	(ø8/200)	(ø8/200)	(ø8/200)
		$a_E \geq$		50 mm	50 mm	50 mm	50 mm	50 mm
		edge	R2	1005	785	503	503	393
				(ø8/50)	(ø10/100)	(ø8/100)	(ø8/100)	(ø10/200)
		$a_E \geq$		230 mm	200 mm	200 mm	110 mm	100 mm
		edge	R3	1571	1571	785	785	785
				(ø10/50)	(ø10/50)	(ø10/100)	(ø10/100)	(ø10/100)
		$a_E \geq$		370 mm	240 mm	340 mm	240 mm	140 mm
Maximum distances (see below)		$a_{M,limit}$ = 6h		960 mm	1080 mm	1200 mm	1320 mm	1440 mm
		$a_{E,limit}$ = 3h		480 mm	540 mm	600 mm	660 mm	720 mm



With distances between the adjacent Thermokorb® ribs of $a_M > a_{M,limit} = 6 \times h$, the slab can be considered a flat slab and punching shear design is required (see table above).





With distances between the adjacent Thermokorb® ribs of $a_M \leq a_{M,limit} = 6 \times h$, the slab can be regarded as being supported along the entire edge and shear design must be carried out for this section.

If the distance of the outermost Thermokorb® rib from the edge of the slab is $a_E \leq a_{E,limit} = 3 \times h$, the length of the perimeter of any required punching shear design must be reduced accordingly.

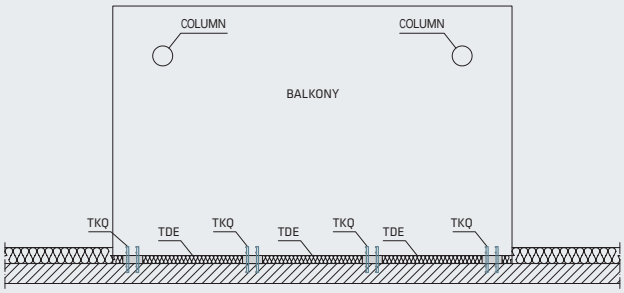
If both the distances between the adjacent Thermokorb® ribs $a_M \leq a_{M,limit} = 6 \times h$ and the distances of the outermost Thermokorb® ribs from the slab edges $a_E \leq a_{E,limit} = 3 \times h$, a shear design must be carried out.

THERMOKORB® TKQ INSTALLATION CASES

GROUND PLANS OF INSTALLATION CASES

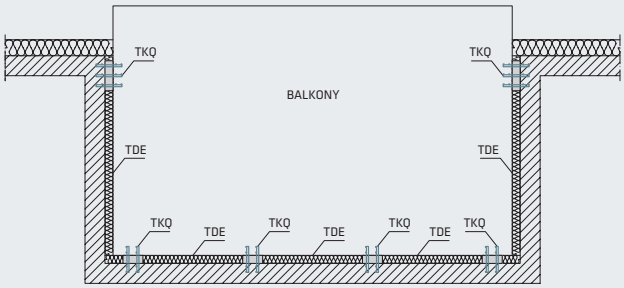
Supported rectangular balcony with TKQ and TDE

- Standard application for supported balconies
- The distance of Thermokorb® TKQ elements should preferably be 1000 mm to match the standard length of the TDE.



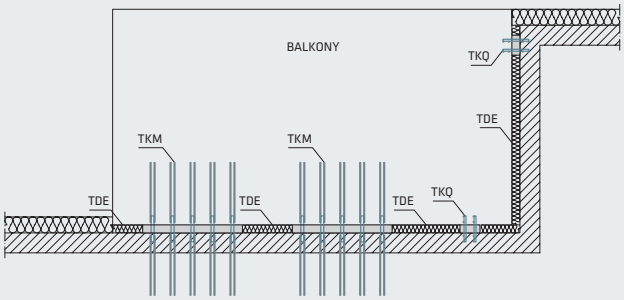
Recessed balcony with TKQ and TDE

- Standard application for recessed balconies
- Application of concentrated loads at the free edge of the balcony
- Support along the entire edge on the building side of the balcony



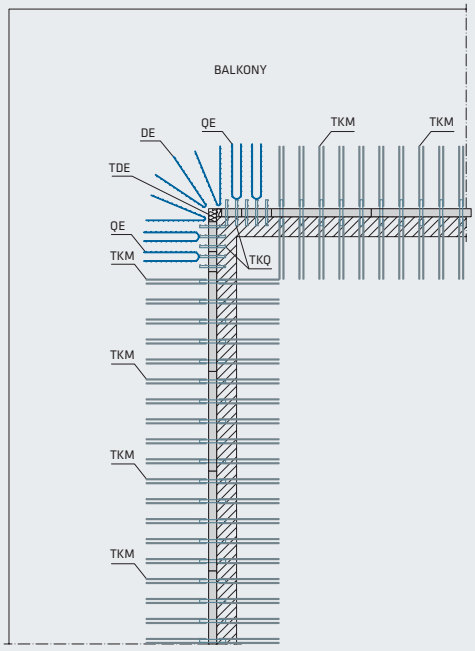
Inner corner balcony with TKQ, TKM, and TDE

- Combined application with Thermokorb® TKM



Outer corner balcony with TKQ, TKM, and TDE

- Combined application with Thermokorb® TKM
- Use of the Thermokorb® TKQ in the corner area in case of high shear loads
- Use of the Thermokorb® TKM in case of moments and shear forces
- With this arrangement, attention must be paid to the deformation of the outer corner
- In the case of high shear loads in the corner area, Shear Reinforcing Elements QE and Punching Shear Reinforcement DE+DKD can be used.



All information about AVI products is available at our website www.avi.at

SECTIONS OF INSTALLATION CASES

Supported balcony – outside wall with thermal insulation composite system

In this exemplary installation situation, the insulation panel of the Thermokorb®TKQ is outside the masonry wall and connects to the thermal insulation composite system.

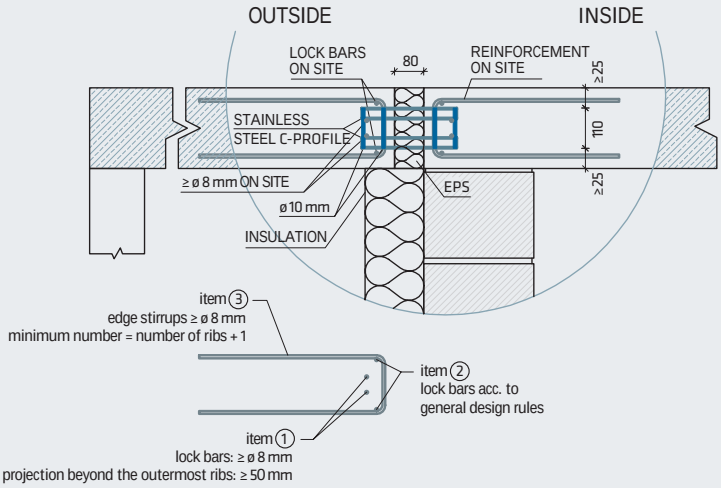


Fig. 5: Supported balcony with TKQ

Supported balcony with precast slab elements on the inside – outside wall without thermal insulation composite system

The insulation panel of the Thermokorb®TKQ is arranged within the masonry wall. In this exemplary installation situation, a slab consisting of precast elements is used on the inside.

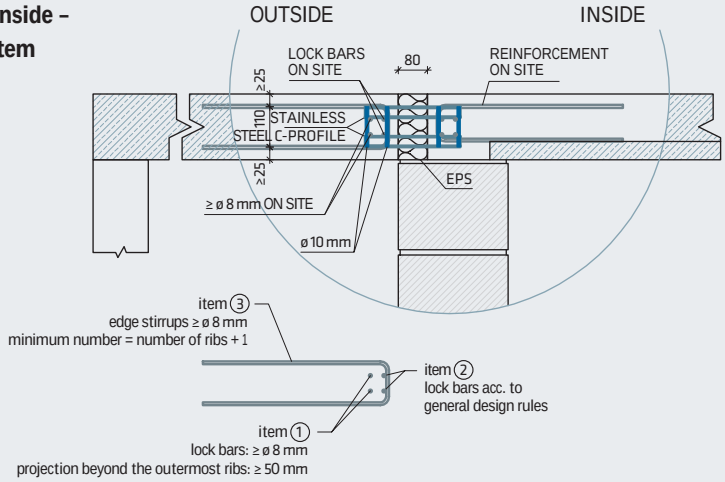


Fig. 6: Supported balcony with precast slab elements inside and TKQ

Supported balcony with a downward level change

Thermokorb® TKQ at a supported balcony with a downward level change.

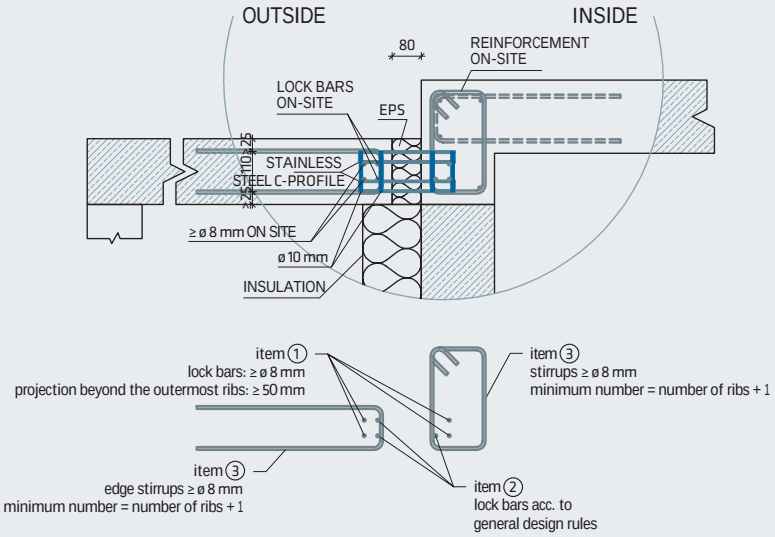


Fig. 7: Supported balcony with a level change downwards and TKQ

Supported balcony with an upward level change

Thermokorb® TKQ at a supported balcony with an upward level change.

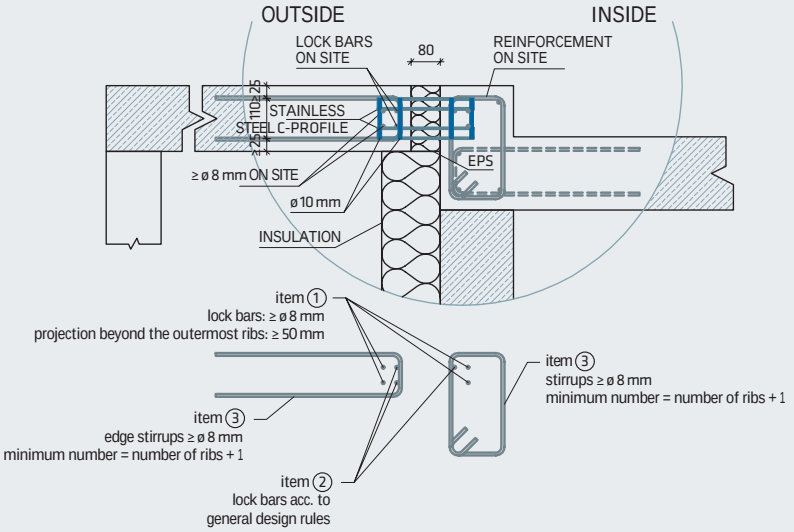


Fig. 8: Supported balcony with a level change upwards and TKQ

Supported balcony –
connection to the wall below
Thermokorb® TKQ at a supported balcony connected to the wall below.

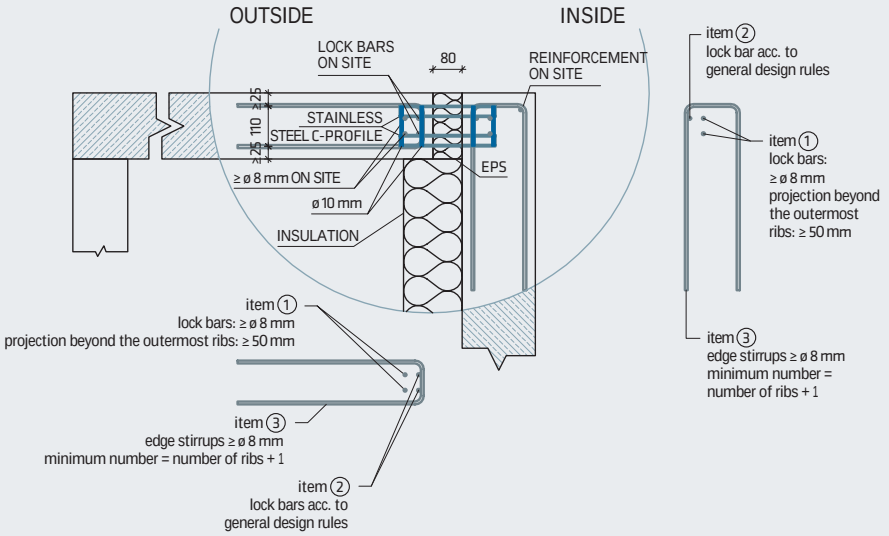


Fig. 9: Supported balcony connected to the wall below and TKQ

Supported balcony –
connection to the wall above
Thermokorb® TKQ at a supported balcony connected to the wall above.

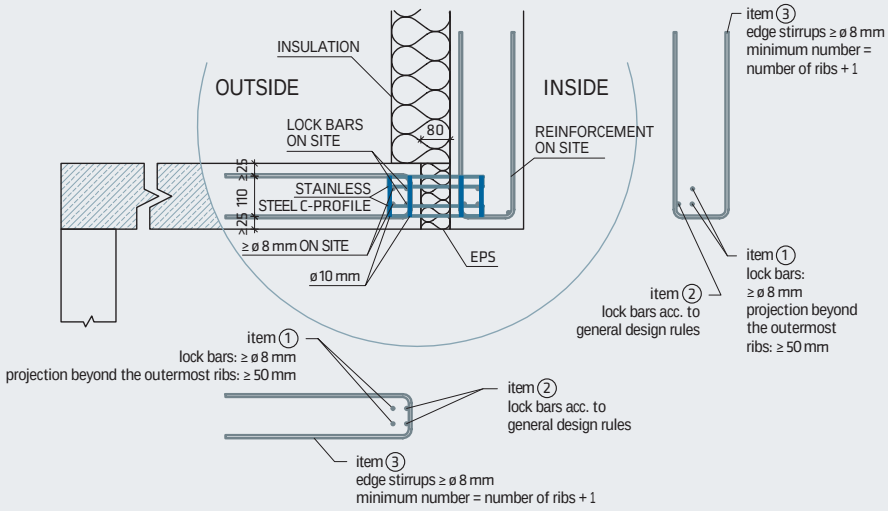


Fig. 10: Supported balcony connected to the wall below and TKQ

Recessed balcony
Thermokorb® TKQ at a recessed balcony.

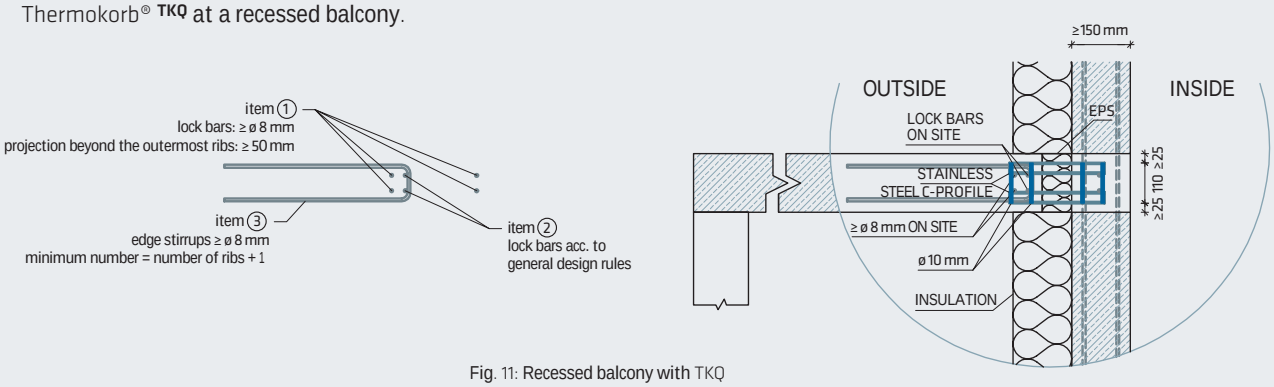


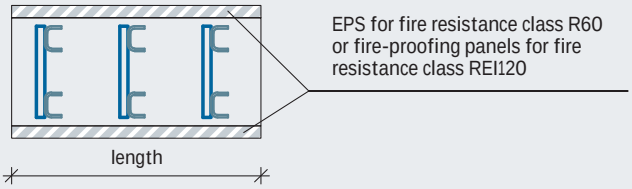
Fig. 11: Recessed balcony with TKQ

DESIGN

DESCRIPTION

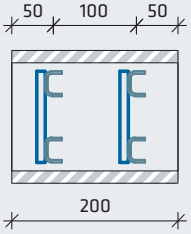
The length of a Thermokorb® TKQ depends on the required number of ribs. Versions with 1, 2, and 3 ribs are manufactured, and these can be combined as desired. For a higher level of fire protection (REI120), fire-proofing panels are arranged on the top and bottom.

Explanation of the length of a Thermokorb® TKQ without/with fire-proofing panels

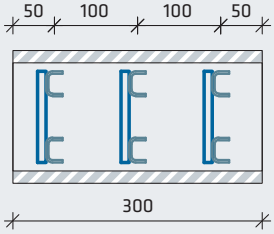


TKQ/R1

TKQ/R2

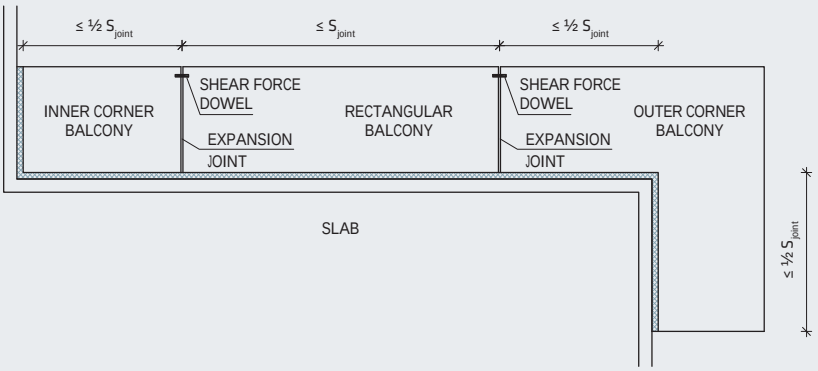


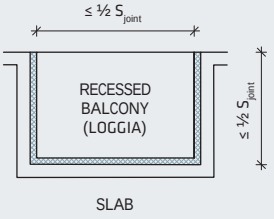
TKQ/R3



DISTANCE OF EXPANSION JOINTS

The maximum expansion joint distance for a cantilevered rectangular balcony without additional support is to be limited to s_{joint} = 12 m. Larger expansion joint distances cause horizontal deformations due to temperature changes. In the case of balconies with two or more edges supported by Thermokorb® elements (recessed balcony, outside or inside corner balcony), the dimensions of the balcony without an expansion joint must not exceed $s_{joint}/2$ = 6 m. To avoid different deflections of the balconies, shear dowels are to be arranged in the expansion joints. The expansion joint distances are to be determined by the structural designer. Depending on the loading and the installation situation, larger expansion joint distances can be specified in coordination with the Technical Service of AVI.





BUILDING PHYSICS - THERMAL INSULATION VALUES

The use of Thermokorb® TKQ for thermal separation reduces heat losses which arise from material-based and geometric thermal bridges. Uninsulated joint areas may also lead to a considerable lowering of the surface temperature of the building component and increase the risk of condensation and mould formation. The use of Thermokorb® TKQ provides a good heat distribution pattern and heating cost savings.

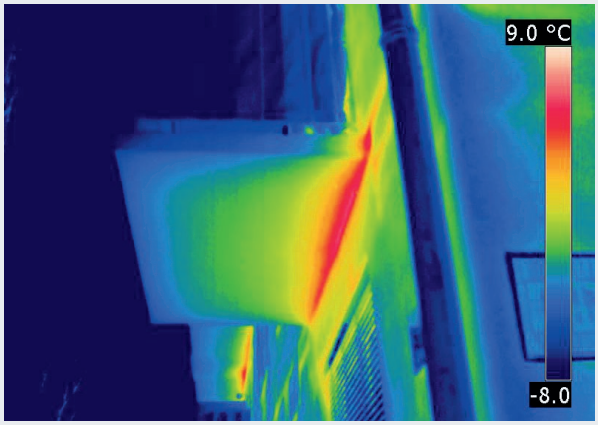


Fig. 13: Uninsulated connection area

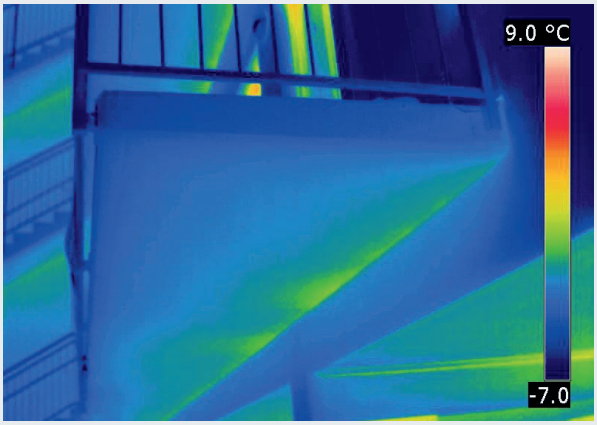


Fig. 14: Connection area using Thermokorb® TK

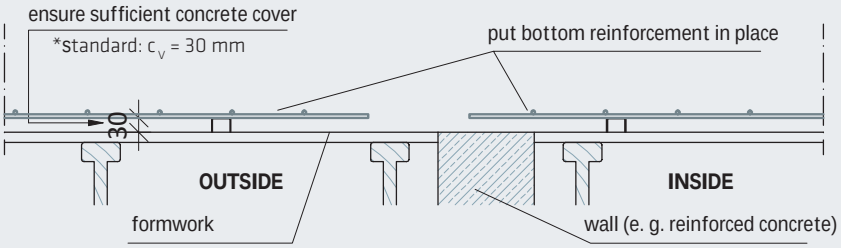
Due to the design of the ribs, the thermal resistance of the Thermokorb® TKQ is independent of the number of ribs. The thermal resistance of the entire thermal separation joint is made up of the thermal resistance of the load-bearing Thermokorb® TKQ (see table) and the non-load-bearing thermal insulation elements TDE.

Note: The values given are based on a simplified calculation.

Building component thickness	Rib height	Characteristic values for rib design	Fire resistance class	
mm	mm		R60	REI120
160	110	λ_{eq} (W/mK)	0.359	0.393
		R_{eq} (m²K/W)	0.223	0.204
180	110	λ_{eq} (W/mK)	0.323	0.352
		R_{eq} (m²K/W)	0.248	0.227
200	110	λ_{eq} (W/mK)	0.293	0.320
		R_{eq} (m²K/W)	0.273	0.250
220	110	λ_{eq} (W/mK)	0.270	0.294
		R_{eq} (m²K/W)	0.297	0.272
240	110	λ_{eq} (W/mK)	0.250	0.272
		R_{eq} (m²K/W)	0.320	0.294
250	110	λ_{eq} (W/mK)	0.241	0.262
		R_{eq} (m²K/W)	0.332	0.305

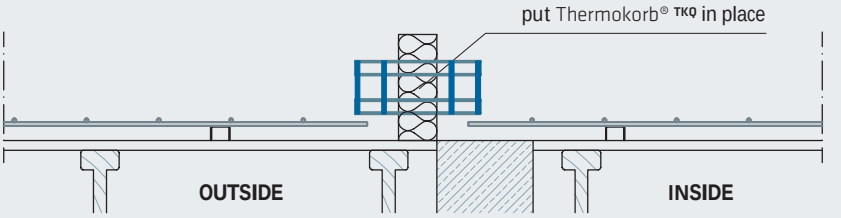
INSTALLATION INSTRUCTIONS

Example: TKQ



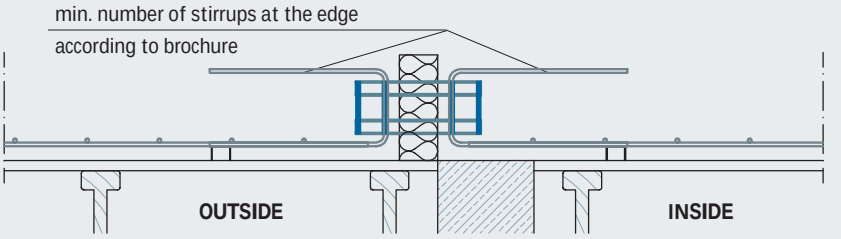
1. Formwork and Bottom Reinforcement

Before placing the Thermokorb® TKQ, the formwork and the bottom reinforcement layer of the entire slab must be put in place, whereby the specified camber of the formwork has to be observed.



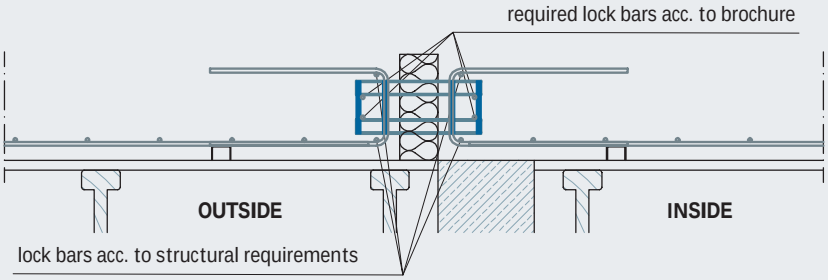
2. Thermokorb®TKQ

The Thermokorb® TKQ is to be placed in the correct position according to the plan and the labels attached.



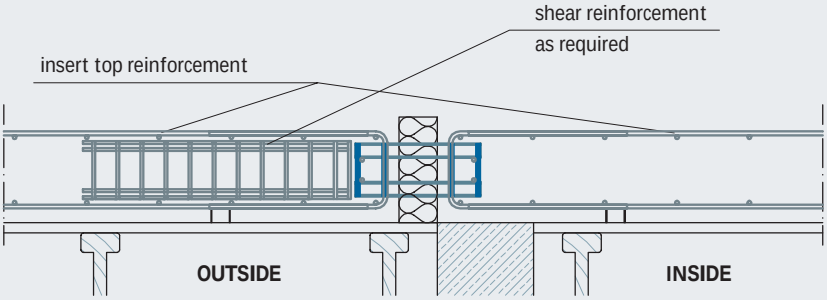
3. Edge Stirrups

The edge reinforcement is to be carried out according to general reinforcement rules. At least one edge stirrup must be arranged next to each TKQ rib. The minimum number of edge stirrups is the number of ribs plus 1, as shown on pages 6 and 7.



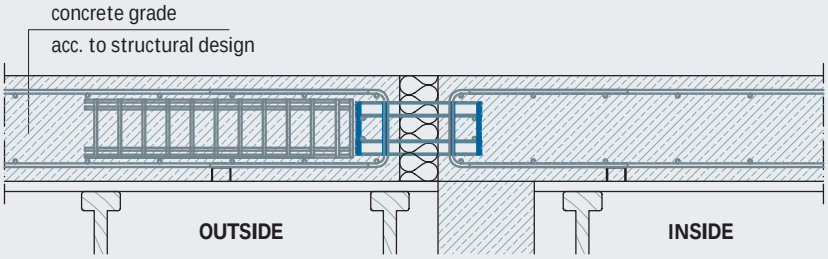
4. Lock Bars

The lock bars for transferring the global moment as well as the lock bars to meet design specifications are to be placed as shown on pages 6 and 7.



5. Top Reinforcement and Shear Reinforcement

Before placing the top reinforcement layer, shear reinforcement (e.g. Shear Reinforcing Element QE) is to be arranged according to the structural design.



6. Concrete

In order to ensure that the Thermokorb® TKQ elements stay in place during concreting, it is essential to pour and vibrate the concrete evenly. It is also recommended to secure the Thermokorb® TKQ elements in place.

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Please direct your inquiries about availability and price of products to our sales department.
For technical inquiries, please contact the Technical Service of AVI (support@avi.at).

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