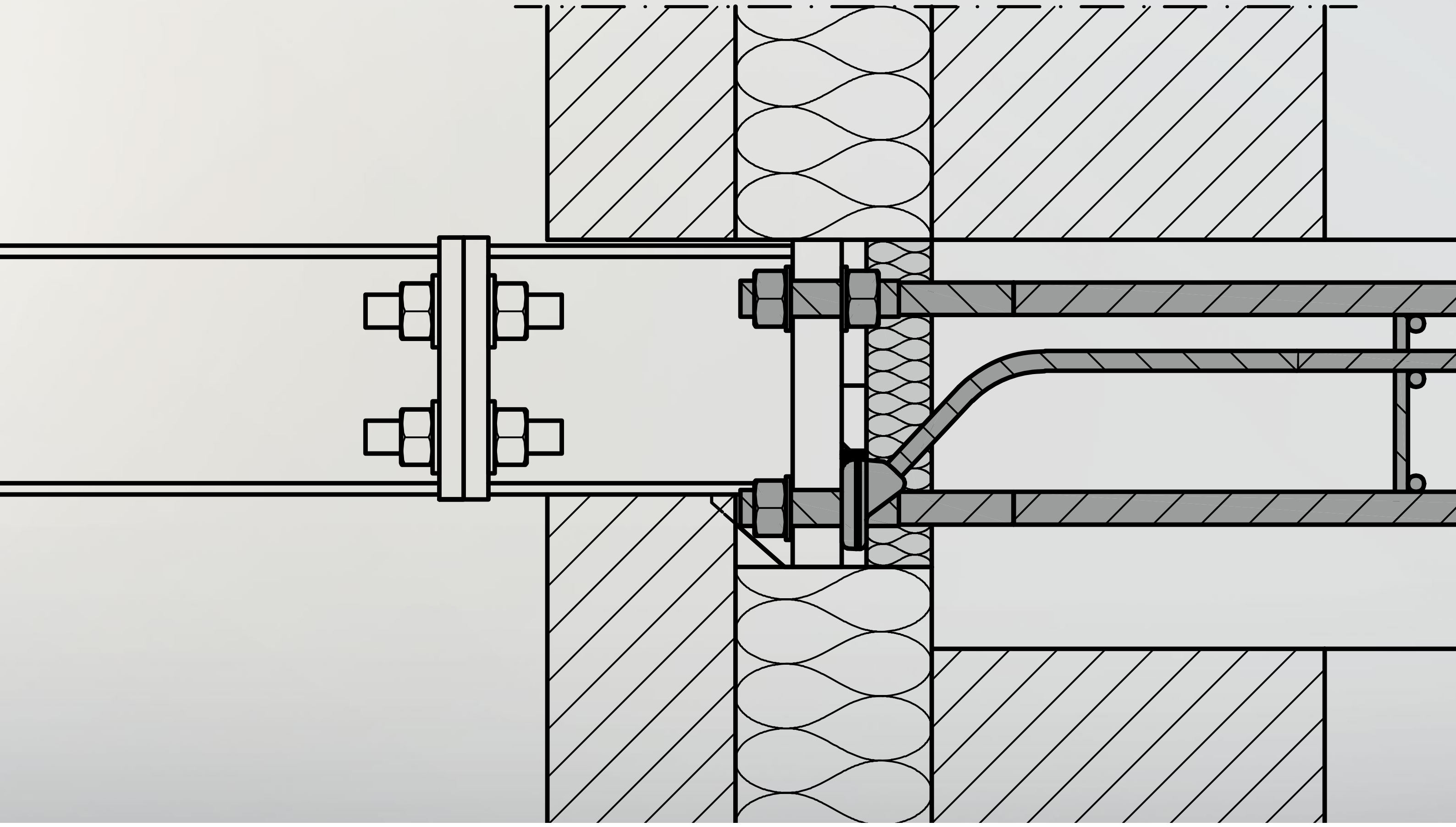


TECHNICAL INFORMATION – MAY 2024

Isokorb® M type SK for modular lightweight balconies

Load-bearing thermal insulation elements
for the effective reduction of thermal
bridges in cantilevered steel constructions.

Planning and consulting service

The engineers of Schöck's technical design department would be very happy to advise you on static, structural and building-physics questions and will produce for you proposals for your solution with calculations and detailed drawings.
For this please send your planning documentation (general arrangements, sections, static data) with the address of the building project to:

Schöck Ltd
Staniford House
4 Wedgwood Road
Bicester
Oxfordshire
OX26 4UL

Telephone hotline for design support services
Tel.: 01865 290 890
Fax: 01865 290 899
E-Mail: design-uk@schoeck.com

Planning tools – downloads and requests
Tel.: 01865 290 890
Fax: 01865 290 899
E-Mail: design-uk@schoeck.com
Web: www.schoeck.com

CPD Seminars and on-site consultation
Tel.: 01865 290 890
Fax: 01865 290 899
Web: www.schoeck.com

Notes | Symbols

Technical Information

- This Technical Information on the respective product application is valid only if complete and therefore may only be reproduced as a whole. With texts and graphics published solely as extracts there is a danger of communicating insufficient or even misleading information. Therefore dissemination is the sole responsibility of the user or the person carrying out the process!
- This Technical Information is valid solely for the United Kingdom and takes into account the country's specific approvals and standards.
- If the installation takes place in another country then the valid Technical Information of the respective country is to be applied.
- The current Technical Information is to be applied. A current version is available at: www.schoeck.com/download-technical-information/uk

Installation instructions

Current installation instructions can be found online at:
www.schoeck.com/download-installation-instructions/uk

Bending of reinforcing steel

With the production of the Schöck Isokorb® in the factory it is ensured through monitoring that the conditions of the general building supervisory approval document and of BS EN 1992-1-1 (EC2) and BS EN 1992-1-1/NA with regard to bending of reinforcing steel are observed.

Attention: If original Schöck Isokorb® reinforcing steels are bent or bent and bent back on-site, the observation and the monitoring of the respective conditions (European Technical Assessment (ETA), BS EN 1992-1-1 (EC2) and BS EN 1992-1-1/NA) lie outside the influence of Schöck Bauteile GmbH. Therefore, in such cases, our warranty is invalidated.

Note on shortening threaded rods

The threaded rods may be shortened on site provided at least two threads remain visible after installation, levelling and final tightening of the balcony structure. Nuts must be re-checked after cutting to ensure they have remained fully tightened.

Notes Symbols

Hazard note

The triangle with exclamation mark indicates a hazard warning. This means there is a danger to life and limb if compliance is not observed.

Info

The square with an "i" indicates important information which, for example, must be read in conjunction with the design.

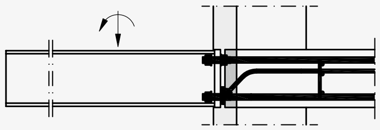
Check list

The square with a tick indicates the check list. Here, the essential points of the design are briefly summarised.

Table of contents

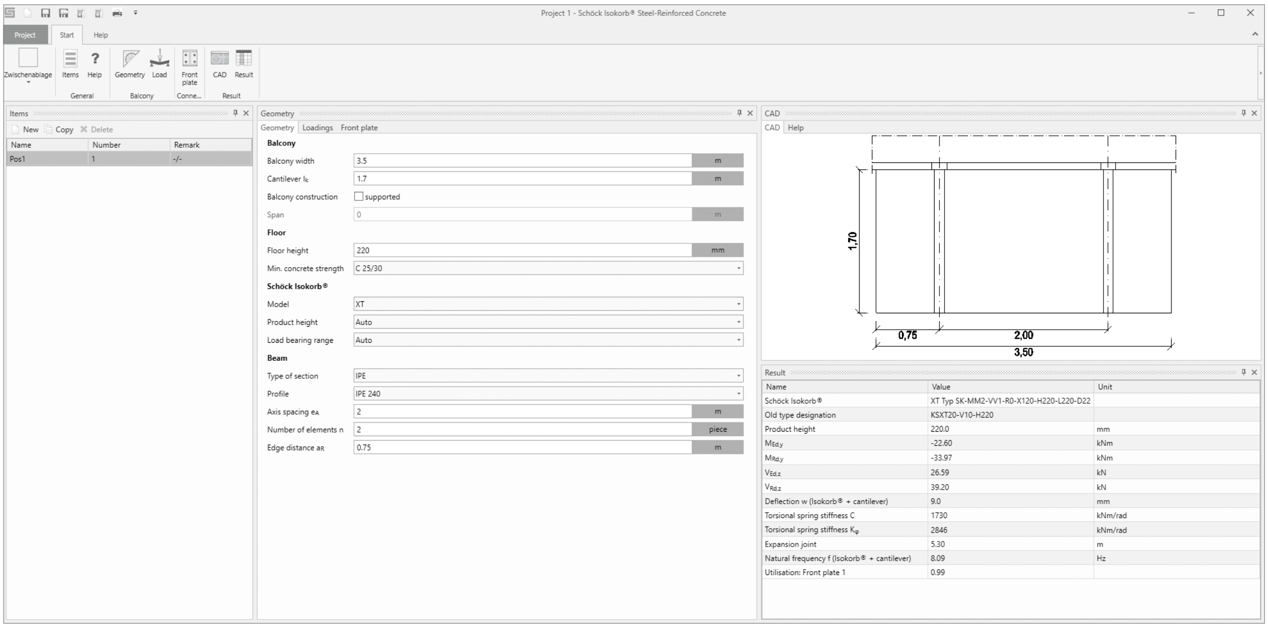
Summary

Summary of types

Application		Schöck Isokorb® type
Free cantilevered steel balconies on reinforced concrete structures		
 M type SK		M type SK Page 17

Design software

The Schöck Isokorb® M type SK can be efficiently designed using the Schöck Isokorb® design software.
The Schöck Isokorb® design software is available at no cost via download. It runs under MS-Windows with MS-Framework 4.6.1



Installation

- At least Windows 7 as well as administrator rights are necessary for the installation of the software; Windows 10 is recommended.
- Upwards from Windows 7, with an update, the software is to be started using administrator rights (right mouse click on Schöck Icon; selection: carry out using administrator rights).

Schöck Isokorb® steel-reinforced concrete software

- With the calculation of the natural frequency of thermally separated steel beams for the verification of the fitness for purpose of balconies

Building physics

Requirements

Thermal bridges are localized areas of lower thermal resistance than the surrounding planar building elements (e.g. a balcony connection penetrating the insulated façade of a building).
These areas of high local heat flow can have a significant impact on the thermal performance of the building envelope and the building energy consumption.

Building Regulations Part L (2021) and associated guidance document for residential construction Approved Document L1A (ADL1A) require that energy losses from thermal bridging are included in the fabric heat loss calculations.

Thermal Bridges – Reduction of Heat Loss
The latest version of Part L (2021) has raised the default additional heat loss through thermal bridges (y-value) from 0.15 to 0.20, which is an increase of 33 %. This means that a consideration of thermal bridges in the SAP calculation by default value (4.18 option d) has an unreasonable impact and "punishes" the planner with a high extra heat loss.

Therefore, it is a big advantage in a new building project to deal with thermal bridges in detail (along with 4.18 option a, b or c). The largest potential lies in the detailed thermal bridge calculation (option a), because standard or default values often have some buffer included for being on the safe side.

The Government Standard Assessment Procedure (SAP 2012) is the simple energy use and carbon emissions model used to provide evidence that the carbon emissions target will be achieved. The SAP calculation includes the term HTB (heat loss due to thermal bridging) which is calculated as follows:

$$H_{TB} = \sum_i \left(L_i \cdot \psi_i \right) \quad [W/K]$$

If there are significant point thermal bridges, such as metal components penetrating insulation layers (e.g. balcony supports), they have to be added:

$$H_{TB} = \sum_i \left(L_i \cdot \psi_i \right) + \sum_i \left(n_i \cdot \chi_i \right) \quad [W/K]$$

- L: length of the thermal bridge in metres over which ψ applies
- ψ: linear thermal transmittance ("Psi")
- n: number of point thermal bridges
- χ: point thermal transmittance ("Chi") of point thermal bridge

Using the new Isokorb® M Type SK as a thermal break significantly reduces the heat loss through the balcony connection. Compared to the default value defined for a balcony connection E23 in SAP it can save up to 80 %.

Thermal Bridges – Mould avoidance and condensation control
Building Regulations Part L (2021) includes the requirement that minimum internal surface temperatures be such that condensation risk is minimized and mould growth avoided.

Condensation and mould risk depend on the relative humidity, which is present at the inner surface of the façade or building construction in general. If the temperature of the inner surfaces is below the dewpoint, the room air will here cool down, so that condensation will occur. For mould growth no condensation is needed, here a relative humidity of about 80 % is sufficient to provide conditions which favour development of mould.

A measure to describe the relation between inner air temperature, outer air temperature and inner surface temperature is the temperature factor f_{Rsi}, which is mentioned in the BRE Information Paper IP1/06 as the critical temperature factor f_{CRsi}.

The minimum temperature factor, which has to be achieved for preventing mould growth, is 0.75 for residential buildings, according to IP1/06. This corresponds to a minimum internal surface temperature of 15 °C (with 0 °C outside and 20 °C inside air temperature).

$$f_{Rsi} = \frac{\theta_{si} - \theta_e}{\theta_i - \theta_e} \quad \text{e.g.} \frac{15.0\,°C - 0.0\,°C}{20.0\,°C - 0.0\,°C} = \frac{15.0}{20.0} = 0.75$$

- θ_{si}: lowest surface temperature at junction
- θ_e: outside air temperature
- θ_i: inside air temperature

Characteristic values of thermal insulation products

Characteristic building-physical values of cantilevered components

Several characteristic values exist for describing the effects of a thermal bridge. The property of a Schöck Isokorb® for preventing heat transfer is described by the equivalent thermal conductivity λ_{eq}. This is a product parameter.

The additional thermal heat loss ψ for a linear thermal bridge is not a product parameter, but is additionally dependent from the construction around the connection and its material properties.

Product parameter	Characteristic value	Isokorb® M type SK	Type of thermal bridge
Equivalent thermal conductivity	λ_{eq}	0.741 W/(m•K)	Cantilevered structural elements such as balconies and parapets, designed with Schöck Isokorb®.
Equivalent resistance to heat transmission	R_{eq}	0.074 m²•K/W	

Equivalent thermal conductivity λ_{eq}

The equivalent thermal conductivity, λ_{eq}, is the overall thermal conductivity of all components of the Schöck Isokorb®, including the steel reinforcement, thermal insulation material, preassure bearings and fire protection plates, and is – at the same insulating element thickness – a measure for the thermal insulating effect of the connection. Lower λ_{eq} translates to higher thermal insulation of the balcony connection. The equivalent thermal conductivity, λ_{eq}, is determined through detailed thermal bridging calculations. Since each product has an individual geometry and structural specification, each Schöck Isokorb® has a unique λ_{eq} value.

The equivalent thermal conductivity of Isokorb® can be used in 2D and 3D thermal analysis software by using a rectangular shape as a substitute insulating element of the same dimensions as the Isokorb® insulation body (here the distance between slab and stub bracket). E.g. for Schöck Isokorb® M Type SK the representing substitute insulating element would be 55 mm thick, 300 mm long and 200 mm high.

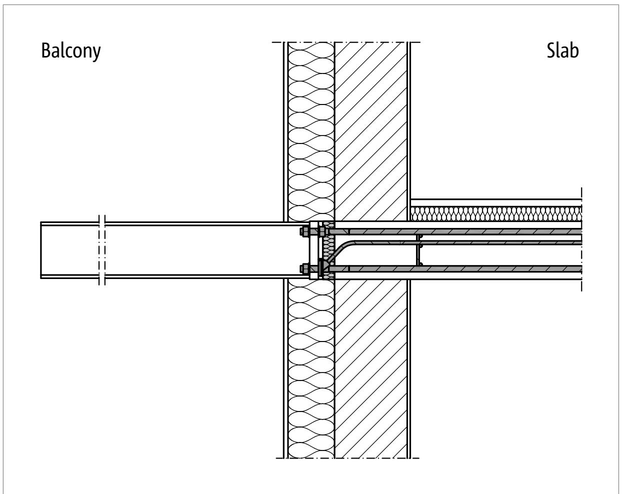


Fig. 1: Representation of a sectional drawing with detailed Schöck Isokorb® model

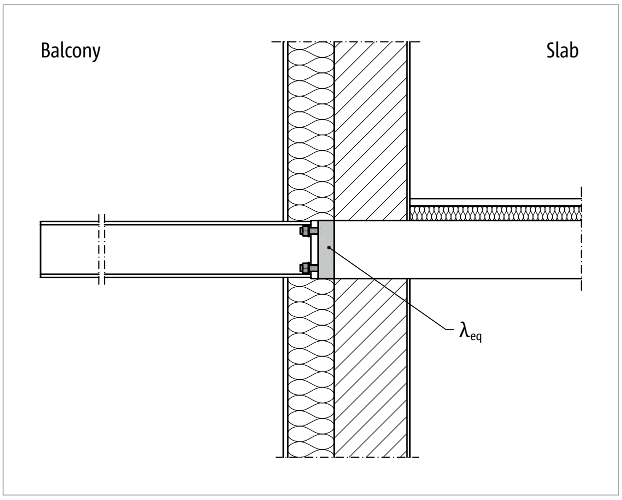


Fig. 2: Representation of a sectional drawing with simplified substitute insulating element

Info

ψ, χ, $\Theta_{si,min}$ and f_{Rsi} are also calculated for a specific thermal bridge – a specific construction in which a specific Isokorb® is embedded. Therefore these values are always dependent on the construction, while λ_{eq} describes only the thermal insulation effect of a Schöck Isokorb®.

Building physics

Verification procedure

As part of the verification procedure, the thermal transmittance χ and ψ as well as the temperature factor f_{Rsi} of the thermal bridge are calculated. An example is presented that is based on a typical construction detail that can be found in UK high-rise residential buildings.

Heat loss

The balcony connection with Isokorb® M Type SK represents a point thermal bridge. The point thermal transmittance χ is calculated according to BRE report BR 497 and for this detail it is 0.32 W/K. If there are two connections used for a balcony of 3.50 m length, this would be equivalent to a linear thermal transmittance of ψ = 0.19 W/(m·K). Compared to the default value stated in SAP 2012 this results in a reduction of 81 %.

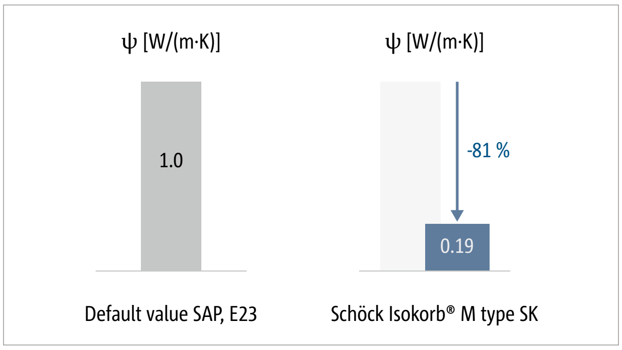


Fig. 3: Significant reduction of the thermal bridge transmission coefficient by more than 80 % compared to the default value of SAP, E23

Temperature factor

The temperature factor is calculated according to BRE report BR 497. When using Isokorb® M Type SK the requirements for the temperature factor f_{Rsi} according to BRE Information PaperIP1/06 are easily fulfilled.

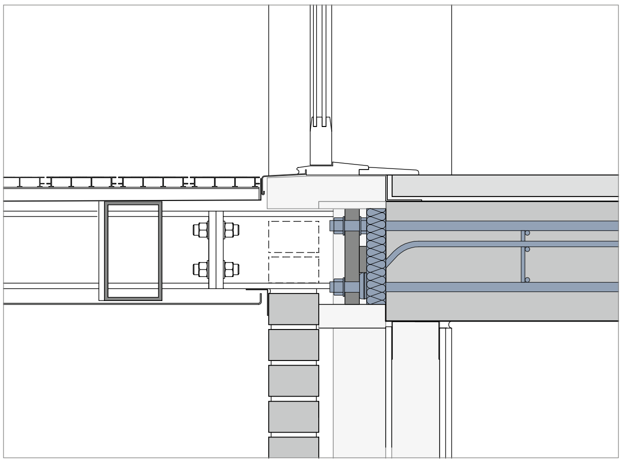


Fig. 4: A standard balcony of 3.5 m length with two Isokorb® M Type SK has been examined

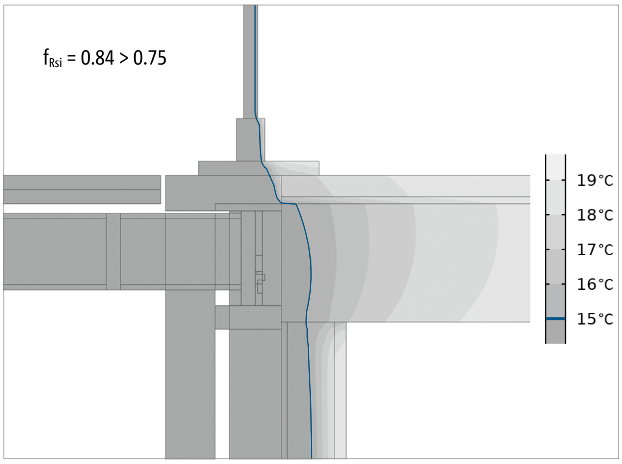


Fig. 5: Thermal model showing all inner surface temperatures being higher than the critical 15 °C (equals to f_{Rsi} of 0.75)

Steel - reinforced con-crete

Construction materials | Corrosion protection

Schöck Isokorb® construction materials

Reinforcing steel	B500B as per BS 4449, BSt 500 NR as per general technical approval
Stainless steel	Grade: 1.4401, 1.4404, 1.4462, 1.4482 and 1.4571, S 460 as per approval no.: Z-30.3-6 Components and connecting devices made of stainless steel or BSt 500 NR
Load-bearing plate	Grade.: 1.4404, 1.4362 and 1.4571 or higher quality e.g 1.4462
Spacer shims	Grade.: 1.4401 S 235, thickness 2 mm and 3 mm, length 180 mm, width 15 mm
Insulating material	Aestuver® – this insulating material is cement-bonded, fibreglass-reinforced lightweight concrete, building material classification A1, λ = 0,23 W/(m·K)

Connected components

Reinforcing steel	B500A or B500B as per BS 4449
Concrete	Minimum concrete on the internal slab side; concrete grade ≥ C 25/30
Structural steel	Minimum S 235 on the balcony side; strength class, structural design and corrosion protection as specified by the structural engineer

Anti-corrosion protection

The stainless steel used in the Schöck Isokorb® M type SK corresponds to material no.: 1.4362, 1.4401,1.4404 or 1.4571. According to general technical approval Z-30.3-6 Annex 1 “Components and connecting elements made of stainless steel”, these steels are classified as resistance class III/medium.

Connections of Schöck Isokorb® M type SK in conjunction with a steel end-plate that has been galvanised or coated with anti-corrosion protection are not at risk of bimetallic corrosion (see approval Z-30.3-6, section 2.1.6.5). As far as the connections of Schöck Isokorb® are concerned, the surface area of the lower-grade material (steel end-plate) is much larger than that of the stainless steel (bolts, washers and saddle plate), failure of the connection due to bimetallic corrosion is excluded.

i Note on shortening threaded rods

The threaded rods may be shortened on site provided at least two threads remain visible after installation, levelling and final tightening of the balcony structure. Nuts must be re-checked after cutting to ensure they have remained fully tightened.

Installation accuracy

Adjusting the height of the steel member:

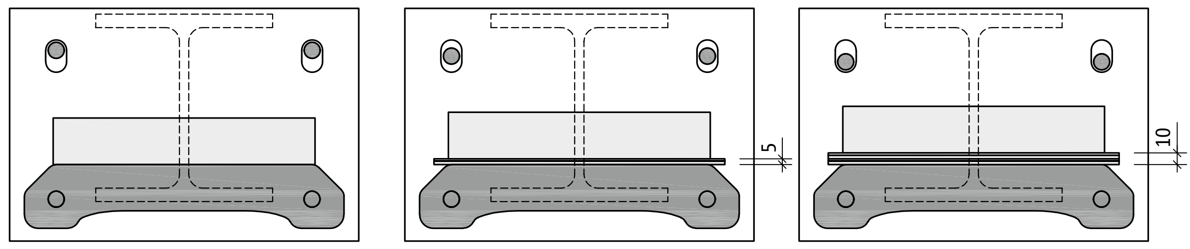


Fig. 6: Schöck Isokorb® M type SK: Adding steel leveling shims (5 mm high) on the load plate will raise the fixing plate and bring the centre of the vertical slots in line with the axes of the thread bolts on the M type SK; using this as a starting level will allow vertical tolerance of ±5 mm

Connection with on-site stub bracket

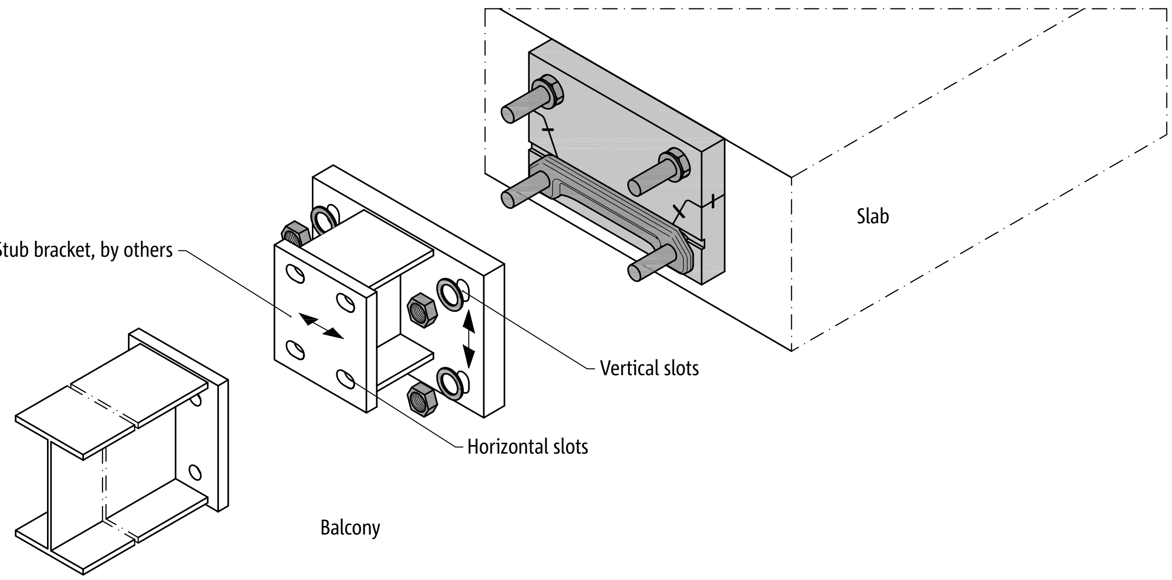


Fig. 7: Schöck Isokorb® M type SK: Cantilever beam connection with stub bracket enables tolerances in vertical and horizontal directions to help overcome dimensional deviations of the reinforced concrete structure; spacer shims are included with the Isokorb®

i Information on installation accuracy

- Design constraints allow a vertical tolerance of 10 mm with the Schöck Isokorb® M type SK. The requisite steel leveling shims are included with the product.
- Horizontal limit deviations for the separation of the M type SK axes must be specified, as must the limit deviations from the alignment. Torsional limits must also be specified.
- The use of a steel template developed on site is highly recommended to ensure dimensionally accurate installation and the correct sitting of the M type SK during the concrete pouring process.
- The construction supervisor is responsible for checking the agreed installation accuracy of the M types SK in good time!

Schöck Isokorb® M type SK

Schöck Isokorb® M type SK-MM2-VV2-NC-X40
Increased stiffness and non-combustible (A2-s1,d0) load-bearing thermal insulation element for the connection of free cantilevered steel structures to reinforced concrete slabs. This element transmits positive and negative moments and shear forces.

Element arrangement | Installation cross sections

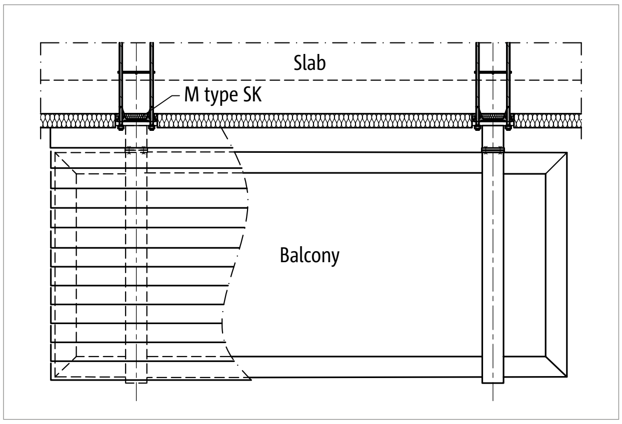


Fig. 8: Schöck Isokorb® M type SK-MM2-VV2-NC-X40: Balcony freely cantilevered

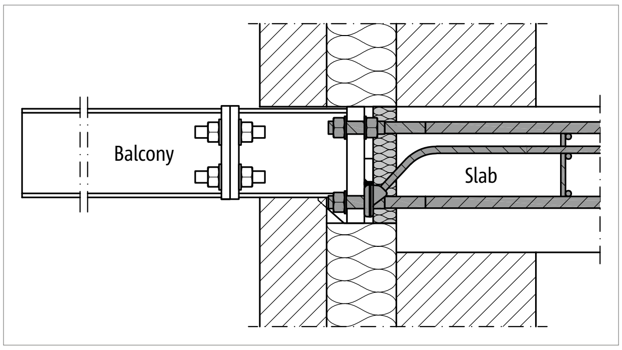


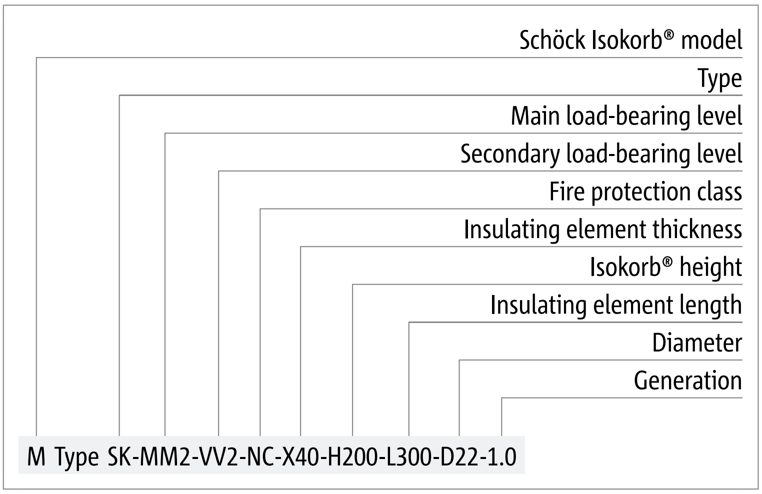
Fig. 9: Schöck Isokorb® M type SK-MM2-VV2-NC-X40: Insulating element inside the core insulation; stub bracket between the Schöck Isokorb® and the balcony to enable flexible installation.

Product selection | Type designations

Variants of the Schöck Isokorb® M type SK with insulating element thickness X40 for increased stiffness
The Schöck Isokorb® M type SK with insulating element thickness X40 can be varied as follows:

- Main load-bearing level:
  Moment load-bearing level MM2
- Secondary load-bearing level:
  For main load-bearing level MM2: Shear force load-bearing level VV2
- Fire protection class:
  NC - non combustible A2-s1, d0
- Insulating element thickness:
  X40 = 40 mm
- Isokorb® height:
  H = 200 mm
- Isokorb® length:
  L = 300 mm
- Thread diameter:
  D22 = M22 for main load-bearing level MM2
- Generation:
  1.0

Type designations in planning documents



Design | Sign convention

Notes on design

- Potential applications for the Schöck Isokorb® encompass floor and balcony slab structures with predominantly static and evenly distributed live loads as per BS EN 1991-1-1/NA, Table 6.1.
- Static evidence must be furnished for the components connecting to both sides of the Isokorb®.
- A minimum of two Schöck Isokorb® M type SK must be installed per balcony structure. The balcony structure must be designed in such a way to prevent torsion being transferred into an individual Isokorb®. Schöck Isokorb® M type SK are unable to transfer any torsion (i.e. any moment $M_{Ed,x}$).
- When using an indirect bearing solution for the Schöck Isokorb® M type SK, the structural engineer must provide evidence, in particular, of the load transfer in the reinforced concrete component.
- Design values are taken in relation to the rear edge of the fixing plate.

Sign convention for the design

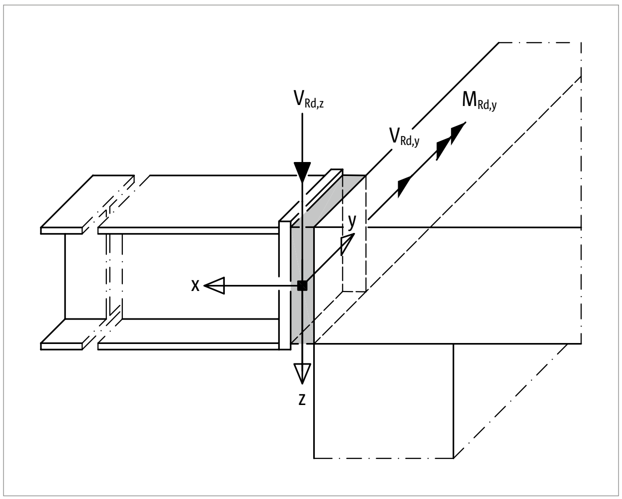


Fig. 10: Schöck Isokorb® M type SK-MM2-VV2-NC-X40: Direction of internal forces and moments

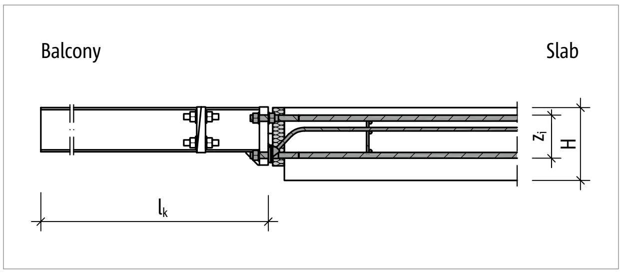


Fig. 11: Schöck Isokorb® M type SK-MM2-VV2-NC-X40: Static system; design values relate to the cantilevered length l_k

Design

Inner lever arm

Schöck Isokorb® M type SK 1.0		MM2
Inner cantilever when		z_i [mm]
Isokorb® height H [mm]	200	128

Design with positive shear force and negative moment

Schöck Isokorb® M type SK 1.0		MM2-VV2		
Design values with		Concrete strength class ≥ C25/30		
		$V_{Rd,z}$ [kN/element]		
		29	35	45
		$M_{Rd,y}$ [kNm/element]		
Isokorb® height H [mm]	200	-31.5	-30.8	-29.6
		$V_{Rd,y}$ [kN/element]		
	200	±6.5		

Design with negative shear force and positive moment

Schöck Isokorb® M type SK 1.0		MM2-VV2
Design values with		Concrete strength class ≥ C25/30
		$M_{Rd,y}$ [kNm/element]
Isokorb® height H [mm]	200	15.6
		$V_{Rd,z}$ [kN/element]
	200	-12.0
		$V_{Rd,y}$ [kN/element]
	200	±6.5

Schöck Isokorb® M type SK 1.0	MM2-VV2
Placement with	Isokorb® length [mm]
	300
Tension bars	2 ⌀ 20
Shear force bars	2 ⌀ 12
Pressure bearing / compression bars	2 ⌀ 20
Thread	M22

Notes on design

- The applied moment capacity $M_{Rd,y}$ is dictated by the applied shear forces $V_{Rd,z}$ and $V_{Rd,y}$. Intermediate values can be determined by linear interpolation. Extrapolation in the range of smaller shear force is not permissible.
- The maximum design values of the shear force load ranges have to be considered:
  VV2: max. $V_{Rd,z}$ = 69.5 kN

Deflection/Camber | Torsional spring stiffness

Deflection
The deflection values shown in the calculation tables result solely from the deformation of the Schöck Isokorb® element. The final deflection / precamber of the balcony structure results from the calculation according to BS 8500, or according to EC 2, plus the deflection / precamber due to the Schöck Isokorb®.
The deflection of the balcony structure to be specified by the engineer in charge.
Deflection (p) caused by the Schöck Isokorb®

p_{SK} = $\tan\alpha \cdot l_k \cdot (M_{Ed,perm} / M_{Rd}) \cdot 10$ [mm]

Factors to be incorporated:

$\tan\alpha$ = Insert value from table
l_k = Cantilever length [m]
$M_{Ed,perm}$ = Relevant bending moment [kNm] for determining the deformation p [mm] caused by the Schöck Isokorb®.
The structural engineer specifies the load combination to be used when calculating the deformation.
(Recommendation: Load combination for calculating the camber according to E C2: $M_{Ed,perm}$ based on 1.0 LL [kNm]
(DL deflection can be precambered using the Schöck Isokorb® M type SK tilt tolerance)
M_{Rd} = Maximum rated moment [kNm] of the Schöck Isokorb®

Sample calculation, see page 29

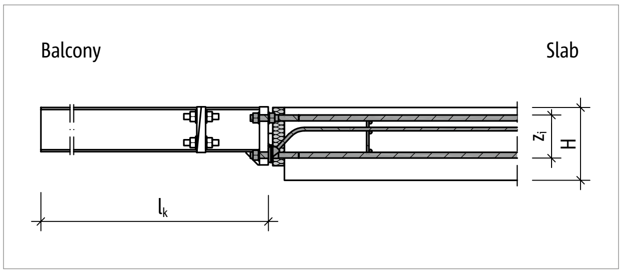


Fig. 12: Schöck Isokorb® M type SK-MM2-VV2-NC-X40: Static system; design values relate to the cantilevered length l_k

Schöck Isokorb® M type SK 1.0		MM2-VV2
Deflection factors when		tan α [%]
Isokorb® height H [mm]	200	0.7

Torsion spring stiffness
The torsion spring stiffness of the Schöck Isokorb® is to be taken into account with the verification of the serviceability limit state. To the extent that an examination of the vibration behaviour of the steel structure to be connected is necessary, the additional deformation resulting from the Schöck Isokorb® must be taken into consideration.

Schöck Isokorb® M type SK 1.0		MM2-VV2
Torsion spring stiffness for (deflection)		C [kNm/rad]
Isokorb® height H [mm]	200	4100

Schöck Isokorb® M type SK 1.0		MM2-VV2
Torsion spring stiffness for (vibration)		k [kNm/rad]
Isokorb® height H [mm]	200	4400

Expansion joint spacing

Expansion joints must be provided in the external component.

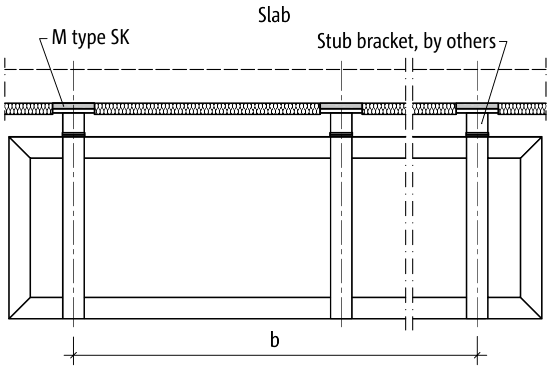


Fig. 13: Schöck Isokorb® type SK: Balcony of length b connected with stub brackets

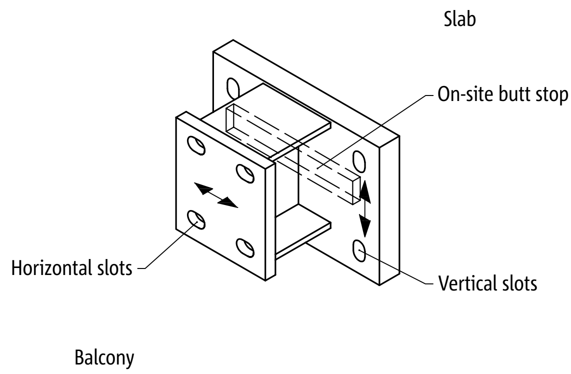


Fig. 14: Schöck Isokorb® M type SK: Stub bracket, by others, to ensure movement ±Δb during temperature expansion

Expansion joints

- Dimension b: Length of the balcony, see drawing
- ±Δb: Maximum change in length of length b due to temperature deformation. ±Δb represents the total change in length of the transverse steel members connecting the cantilever steel beams.
- If the horizontal slots of the stub brackets permanently allow temperature-dependent displacements of the transverse steel members of ±Δb/2 the demand for the expansion joint distance is satisfied.
- Horizontal slots according to EN 1090-2:2018

Product description

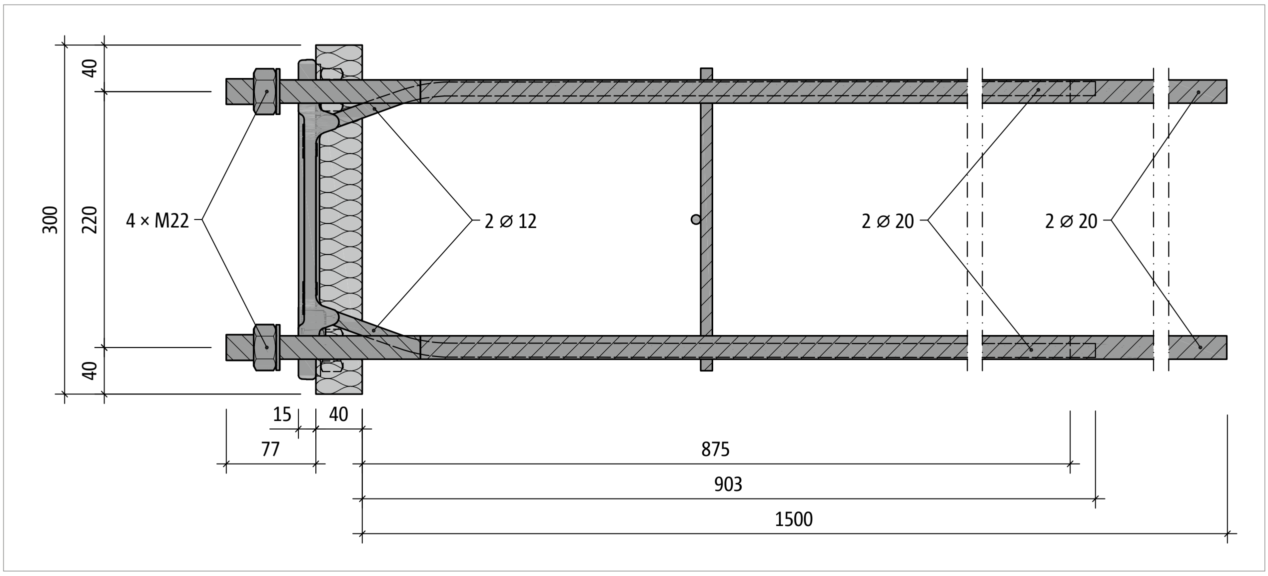


Fig. 15: Schöck Isokorb® M type SK-MM2-VV2-NC-X40: Plan view

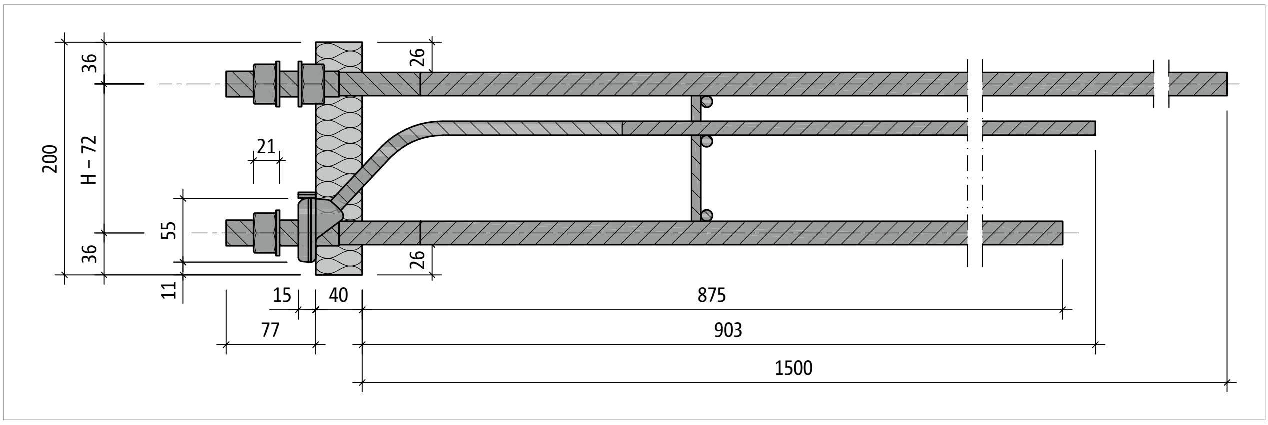


Fig. 16: Schöck Isokorb® M type SK-MM2-VV2-NC-X40: Cross-section

Product information

- M type SK-MM2-VV2-NC-X40: The free clamping distance is 35 mm.

On-site reinforcement

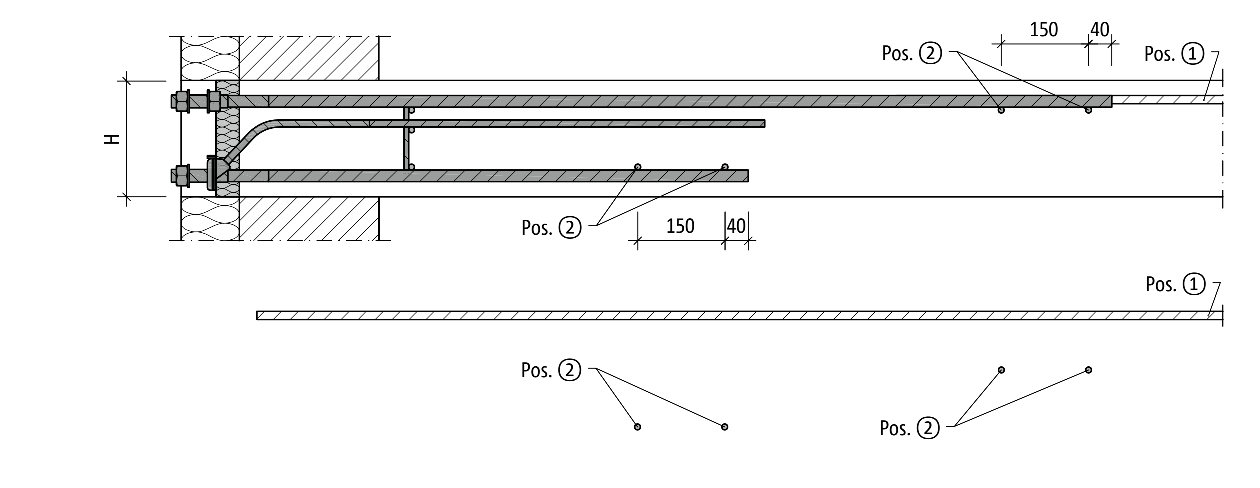


Fig. 17: Schöck Isokorb® M type SK-MM2: On-site reinforcement; section

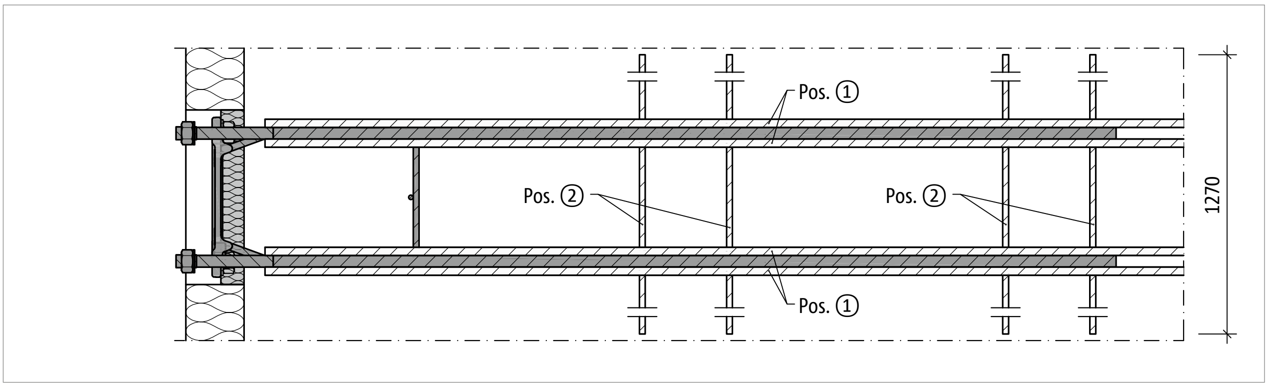


Fig. 18: Schöck Isokorb® M type SK-MM2: On-site reinforcement: Plan view

Schöck Isokorb® M type SK 1.0			MM2
On-site reinforcement	Type of bearing	Height H [mm]	Floor slab (XC1) concrete grade ≥ C25/30 Balcony steel structure
Overlapping reinforcement			
Pos. 1	direct/indirect	200	4 • H16
Lateral reinforcement			
Pos. 2	direct/indirect	200	4 • H10

Information about on-site reinforcement

- M Type SK-MM2: In the case of exposure to uplifting loads (+M_{Ed}), as planned, an overlapping joint with the lower Isokorb® reinforcement may be necessary to cover the tensile force curve. The structural engineer must indicate whether this overlapping reinforcement is required.
- Pos. 2: The location and the given centre distance of the reinforcement must be assured. Transverse reinforcement provided for other reasons can be taken into account.

M
type SK

Steel – reinforced concrete

End Plate

M type SK-MM2 for transferring moment and positive shear force

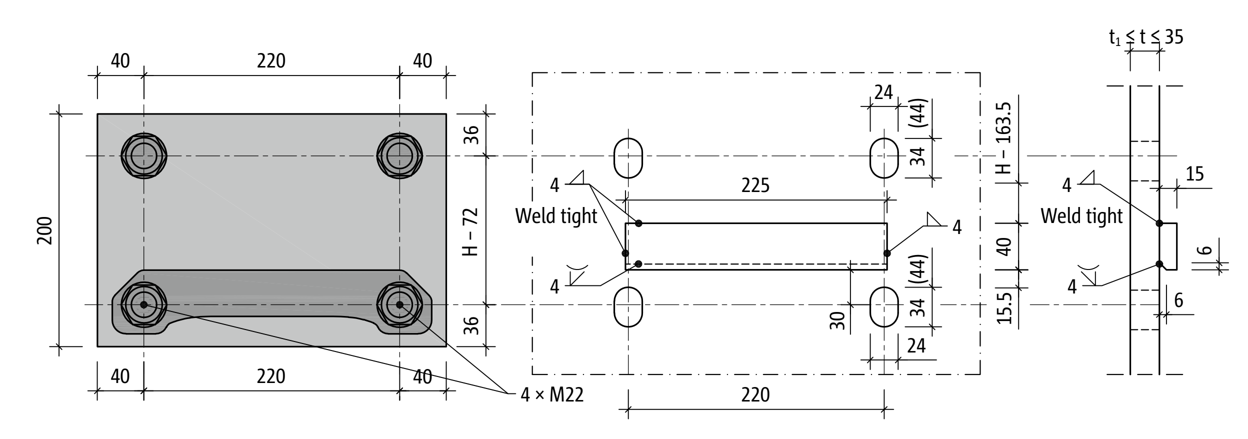


Fig. 19: Schöck Isokorb® T type SK-MM2: Design of the face plate connection

The choice of fixing plate thickness t is determined by the minimum thickness t_1 as specified by the structural engineer. This thickness must not, however, be greater than the clamping distance of the Schöck Isokorb® M type SK.

End Plate

- The illustrated elongated holes allow an uplifting of the endplate of up to 10 mm. The values shown in brackets allow for the increase of the tolerance up to 20 mm if required.
- The distance of the elongated holes to the flange of the beam may need to be checked depending on steel section selected.
- If uplifting loads occur as planned, the lower section of the fixing plate must have round holes (rather than slots). This will result in reduction of the vertical tolerance.
- If horizontal forces $V_{Ed,y} > 0{,}342 \cdot \text{min. } V_{Ed,z}$ parallel to the insulation joint occur, the lower section of the fixing plate must also be modified with round holes instead of slots to ensure load transfer.
- The structural engineer must specify the overall dimensions of the fixing plate

Tightening torque

- The construction drawing must contain the tightening torque for the nuts, which is specified as follows:
  M type SK-MM2 (threaded rod ⌀ 22): M_r = 200 Nm

On-site butt stop

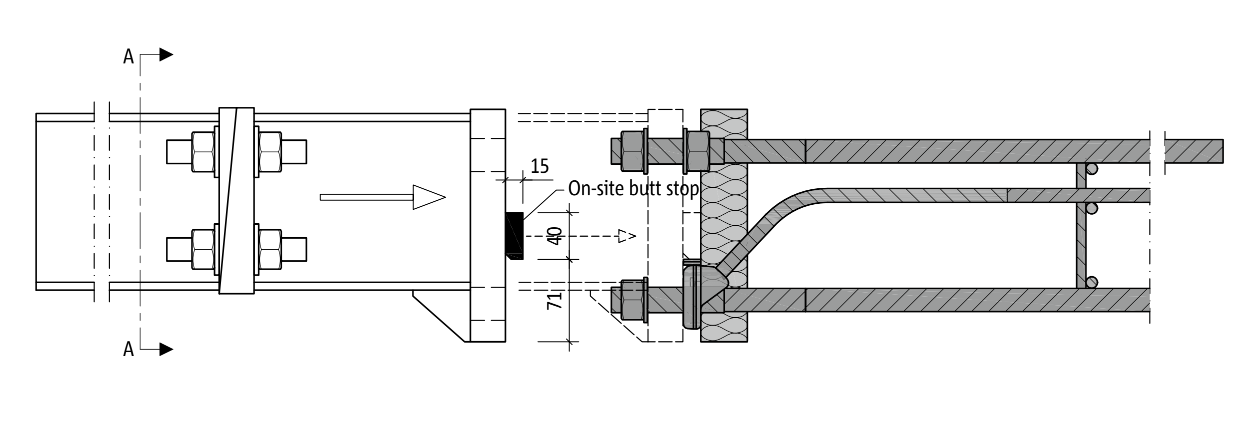


Fig. 20: Schöck Isokorb® M type SK: On-site butt stop for the transfer of the shear force

On-site butt stop

- Type of steel to match static requirements.
- Apply corrosion protection after welding.
- Steel construction: Checking for dimensional inaccuracy of the structure prior to fabrication is absolutely essential!

Spacer shims

- Details of dimensions and materials, see chapter Construction materials.
- With installation ensure they are free from burrs and are even.

Design example

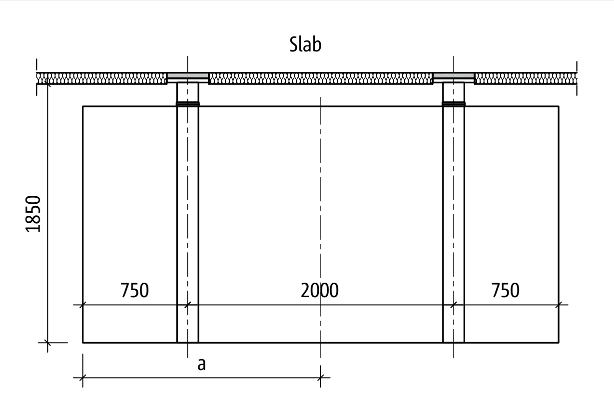


Fig. 21: Schöck Isokorb® M type SK: Balcony freely cantilevered

Static system and load assumptions

Geometry:	Cantilever length	l_k = 1.85 m
	Balcony width	b = 3.50 m
Thickness of reinforced concrete inner slab		h = 250 mm
Length of balcony supported by Schöck Isokorb® M type SK		a = 1.75 m

Load assumptions:	Self-weight with lightweight finish	g_B = 1.5 kN/m²
	Live load	q = 2.5 kN/m²
	Self-weight of railing	F_G = 0.8 kN/m
Horizontal load on railing at rail height 1.1 m		H_G = 0.74 kN/m
Exposure class:	XC 1 on the inside	
chosen:	Concrete grade C25/30 for the floor slab	
	Concrete cover min c_v = 26 mm for Isokorb® tension rods	

Connection geometry:	No height offset, no inner slab joist on slab edge, no balcony upstand
Floor slab bearing:	Slab edge: directly supported
Balcony bearing:	Cantilever arms (152x152x37 UC) clamped with M type SK

Proof of limits of load-bearing capacity (moment stress and shear force)

Member forces:

$M_{Ed} = -[(\gamma_G \cdot g_B + \gamma_Q \cdot q) \cdot l_k^2/2 \cdot a + \gamma_G \cdot F_G \cdot a \cdot l_k + \gamma_Q \cdot \psi_0 \cdot H_G \cdot 1.1 \cdot a]$

$M_{Ed} = -[(1.35 \cdot 1.5 + 1.5 \cdot 2.5) \cdot 1.85^2/2 \cdot 1.75 + 1.35 \cdot 0.8 \cdot 1.75 \cdot 1.85 + 1.5 \cdot 0.7 \cdot 0.74 \cdot 1.1 \cdot 1.75] = -22.3$ kNm

$V_{Ed} = (\gamma_G \cdot g_B + \gamma_Q \cdot q) \cdot a \cdot l_k + \gamma_G \cdot F_G \cdot a$

$V_{Ed} = (1.35 \cdot 1.5 + 1.5 \cdot 2.5) \cdot 1.75 \cdot 1.85 + 1.35 \cdot 0.8 \cdot 1.75 = +20.6$ kN

Requisite number of connections: n = 2 connections

chosen: **2x Schöck Isokorbs® M type SK-MM2-VV2-R0-X40-H200-L300-1.0**

M_{Rd} = -31.5 kNm > M_{Ed} = -22.3 kNm

V_{Rd} = +29.0 kN (see page 21) > V_{Ed} = +20.6 kN

Design example

Verification in the serviceability limit state (deformation/camber)

Check deflection ρ versus allowable limit of L/180 for cantilever – $\rho_{allowable}$ = 1850/180 = 10.25 mm

Deflection factor: $\tan\alpha$ = 0.7 (from table, see page 22)

Chosen load combination: $1.0 \cdot q$ (DL deflection can be precambered using the SK tilt tolerance)
(recommendation for the determination of the camber from Schöck Isokorb®)
$M_{Ed,perm}$ determine in the serviceability limit state
$M_{Ed,perm} = -[(q_1) \cdot l_k^2/2 \cdot a + \psi_0 \cdot H_G \cdot 1.1 \cdot a]$
$M_{Ed,perm} = -[(1.0 \cdot 2.5) \cdot 1.85^2/2 \cdot 1.75 + 0.7 \cdot 0.74 \cdot 1.1 \cdot 1.75] = -8.5$ kNm

Deflection: $\rho_{SK} = [\tan\alpha \cdot l_k \cdot (M_{Ed,perm}/(M_{Rd}))] \cdot 10$ [mm]
$\rho_{SK} = [0.7 \cdot 1.85 \cdot (-8.5/-31.5)] \cdot 10$ [mm] = 3.5 mm

Check deflection ρ_{steel} of steel cantilever beam. Assume section size 152x152x37 UC (E = 210000 N/mm^2, I = 2210 cm^4)

Deflection: $\rho_{steel} = wl_k^4/8EI + w_{rail}l_k^2/2EI$ (where $w = q \cdot a$ and $w_{rail} = \psi_0 \cdot H_G \cdot 1.1 \cdot a$)
ρ_{steel} = 1.4 + 0.4 = 1.8 mm
$\rho = \rho_{SK} + \rho_{steel}$ = 3.5 + 1.8 = 5.3 mm
Total ρ = 5.3 mm < $\rho_{allowable}$ = 10.25 mm

Notes on design

- A structural engineer should design the balcony structure, including end plates, stub brackets and balcony chassis to ensure sufficient rigidity of the structure.
- Natural frequency of the balcony can be calculated using Schöck Isokorb® steel-concrete software. Alternatively, the torsional spring stiffness, k value can be applied in proprietary FE software

☑ Check list

Check list for structural engineers

- ☐ Have the loads on the Schöck Isokorb® connection been specified at design level?
- ☐ Are the minimum concrete strength and exposure classes specified in the implementation plans?
- ☐ Is there a situation in which, during the construction phase, the construction had to be dimensioned for an emergency or a special load?
- ☐ Is the stiffness of the support taken into account with the design of statically indefinite constructions?
- ☐ Has the transfer of the forces in the reinforced concrete component been verified?
- ☐ Have the fire protection requirements for the overall load-bearing structure been clarified? Are the on-site measures included in the construction drawings?
- ☐ Is the Schöck Isokorb® connection exposed to uplifting shear forces in conjunction with positive connection moments?
- ☐ When calculating the deflection of the overall structure, has the camber caused by Schöck Isokorb® been taken into account?
- ☐ Are temperature deformations directly attributed to the Isokorb® connection and has the maximum expansion joint spacing been taken into consideration in this respect?
- ☐ Is compliance with the conditions and dimensions of the on-site fixing plate assured?
- ☐ Do the construction drawings contain sufficient reference to the essential on-site butt stop?
- ☐ Have the requirements for on-site reinforcement of connections been defined in each case?
- ☐ Has reasonable agreement been reached between the concrete and steel contractors with regard to the accuracy of installation of the Isokorb® M type SK to be achieved by the concrete contractor?
- ☐ Has the information about the required installation accuracy been incorporated into the concrete frame designs for the construction supervisor and a concrete contractor construction documents?
- ☐ Are the tightening torques for the bolted connections noted in the construction drawings?

Check list for concrete contractor

- ☐ Does a formwork concept exist for developing an on-site template for installing the Isokorb®?
- ☐ Is installation aid (supplied by others) required to ensure best possible correct sitting and alignment of the Isokorb®?
- ☐ Are you in contact with the steel constructor to discuss the required accuracy of the Isokorb® installation?
- ☐ Has the additional required in-situ reinforcement for the Isokorb® been put in place?

Check list for steel constructors

- ☐ Has the position of the installed Isokorb® in the building structure been measured to determine the height of the on-site butt stop?
- ☐ Do the fixing plates of the adapters contain the necessary vertical/horizontal slots for on-site tolerance?
- ☐ Is the on-site butt stop present on the fixing plate for connecting the steel member to the Isokorb®?
- ☐ Has the necessary tightening moment for the nuts on the Isokorb® been taken into consideration?
  M type SK-MM2 (M22 thread): Mr = 200 Nm

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