Schöck Isokorb® Structural Thermal Break

Schöck Isokorb® Products

Schöck Isokorb® Structural Design

Schöck Isokorb® Installation
Schöck Isokorb® Thermal Insulation
Thermal protection

Minimizing our use of energy and natural resources are vital components of the global strategy to protect our environment and mitigate climate change. Buildings and the construction sector represent a large portion of total global energy and resource consumption. Ontario has responded to this awareness with a tightening of building energy and performance standards. For example, these new requirements are demonstrated in the Ontario Building Code (OBC) Supplementary Standard SB-10, and the new NECB. The mandated energy requirement for buildings has been reduced by about 25% from the previous standard.

In Canada about 40% of the energy consumed in buildings is space heating. Therefore, improving the building envelope using innovative construction methods and products is an efficient way to save on operational energy and improve building durability. Standard improvement strategies include reducing the window to wall ratio, using high-performance window systems and improving facade insulation by reducing thermal bridging.

Uncontrolled thermal bridging, such as balcony slabs running through the building envelope, results in high values of energy loss and the potential for premature structural damage. The impact of thermal bridging increases proportionally with the overall thermal performance of the building envelope when the sources of the bridging and the associated temperature differential are not adequately addressed.

What is a thermal bridge?

Thermal bridges are localized assemblies within the building envelope where high levels of heat loss occur and result in low internal surface temperatures, which create conditions for condensation and mold growth. Typical thermal bridging assemblies include uninsulated balcony slabs penetrating the building envelope, conductive window frames, and gaps in the continuity of insulation.

In the case of uninsulated balcony slab connections, the interaction of the geometrical thermal bridge (cooling fin effect of the balcony slab) and the material-related thermal bridge (high heat conductivity of a reinforced concrete slab) results in a great deal of heat loss, meaning that the uninsulated balcony connection is one of the most critical thermal bridges in the building envelope.

Impact of thermal bridges

In the area surrounding the thermal bridge, the additional local heat loss leads to a reduction in the internal surface temperatures. If the surface temperature drops below the dew point temperature, moisture in the air will condense on the cold surfaces. As soon as the surface temperature drops below the so-called mold temperature there is a risk of mold spores entering the room air. Mold has very serious health impacts and can trigger asthma and cause strong allergic reactions. The low surface temperatures also lead to unnecessary thermal discomfort due to radiant heat loss from the occupant’s body.

Summary of the effects of thermal bridge:

- Risk of mould and dew formation
- Risk of effect on health (allergies etc.)
- Additional heating energy loss
- Discomfort

Increased risk of mold with uninsulated balconies
Additional heat loss with uninsulated balconies
Schöck Isokorb® Thermal Insulation
The balcony as a thermal bridge

Thermal protection with the Schöck Isokorb®

The Schöck Isokorb® makes it possible to thermally insulate the balcony detail at the insulated wall by replacing the continuous reinforced concrete with a thermally insulated connection using the Schöck Isokorb® component.

Reinforcing steel (k = 50 W/(m·K)) is replaced with stainless steel (k = 15 W/(m·K)), and the concrete (k = 1.6 W/(m·K)) is replaced with insulating material (k = 0.031 W/(m·K)). This reduces heat conductivity in the connection area by approximately 90%, and minimizes the heat loss via the balcony by about 80%. The thermal insulation provided by the Schöck Isokorb® increases the surface temperature in the living area by more than 17°C (this so called minimum surface temperature $\Theta_{\text{min}}$ is explained on the next page), depending on the nature of the structure, see the illustration below. The risk of mold formation is also minimized, and the insulated building envelope is effectively made continuous.

Illustration of a conventional building structure without thermal insulation of the balcony structure, with typical building component characteristics.

Illustration of a balcony structure with thermal insulation provided by the Schöck Isokorb, with typical building component characteristics.

The diagrams above illustrate the difference between a conventional construction method and thermal insulation using the Schöck Isokorb®. In a conventional building structure the heat can freely flow out of the interior via the balcony slab, which causes low surface temperatures $\Theta_{\text{min}}$. The Schöck Isokorb® can minimize the loss of thermal energy and thus is an effective method for reducing heat loss, and preventing damp walls and associated structural damage.
Schöck Isokorb® Thermal Insulation
Key thermal values for the products

Equivalent thermal conductivity \( k_{eq} \)

The equivalent thermal conductivity \( k_{eq} \) is the average overall thermal conductivity of the Schöck Isokorb® insulating element for the different surface proportions. If the insulating elements are of the same thickness, it is a measure of the thermal insulation effect of the connection. The smaller \( k_{eq} \) is, the greater the thermal insulation of the balcony connection. Since the equivalent thermal conductivity of the surface proportions of the materials that are used is taken into consideration, \( k_{eq} \) is dependent upon the load capacity of the Schöck Isokorb®.

Thermal transmission resistance \( R \) and \( R_{eq} \)

The \( R \)-value is a measure of heat conduction through a certain layer of a given thickness. It is dependent on the thermal conductivity \( k \) and the layer thickness of a material. With multi-layer components, the \( R \)-value for the entire component results from the sum total of all \( R \)-values. The greater the \( R \)-value, the better the thermal insulating characteristic. The equivalent thermal transmission resistance \( R_{eq} \) describes the thermal conductivity \( k \) through the Schöck Isokorb® and can be expressed as:

\[
R = \frac{d}{k} = \frac{\text{Component thickness}}{\text{Thermal conductivity}}
\]

\[
R_{eq} = \frac{d_{\text{Isokorb}}}{k_{eq}} = \frac{80 \text{ mm thickness of the Isokorb}}{\text{equivalent thermal conductivity of the Isokorb}}
\]

Keep in mind, the \( R_{eq} \)-value does not include the surface conductances and the resistances for air.

The minimum surface temperature \( \Theta_{min} \)

The lowest surface temperature that occurs in the vicinity of a thermal determines the potential of the formation of condensation or mold. The minimum surface temperature therefore dictates the effects of a thermal bridge with regard to moisture effects.

Key thermal values

<table>
<thead>
<tr>
<th>Isokorb® type</th>
<th>( k_{eq} )-value [W/(mK)]</th>
<th>Slab thickness [mm]</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>180</td>
<td>200</td>
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<tr>
<td>CM10</td>
<td>0.161</td>
<td>0.148</td>
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<tr>
<td>CM20</td>
<td>0.193</td>
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<td>CM30</td>
<td>0.225</td>
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<tr>
<td>CM40</td>
<td>0.257</td>
<td>0.232</td>
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</table>

<table>
<thead>
<tr>
<th>Isokorb® type</th>
<th>( R_{eq} )-value [m²K/W]</th>
<th>Slab thickness [mm]</th>
</tr>
</thead>
<tbody>
<tr>
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<td>180</td>
<td>200</td>
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<tr>
<td>CM10</td>
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<td>0.541</td>
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<tr>
<td>CM20</td>
<td>0.415</td>
<td>0.455</td>
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<tr>
<td>CM30</td>
<td>0.356</td>
<td>0.392</td>
</tr>
<tr>
<td>CM40</td>
<td>0.311</td>
<td>0.345</td>
</tr>
</tbody>
</table>
Schöck Isokorb® Product Description and Applications

Contents

| Design and materials for Schöck Isokorb® | 14 - 17 |
| Schöck Isokorb® Fire Protection | 17 |
| Certification of the Schöck Isokorb® | 17 |
| Building with Schöck Isokorb® | 12 |
| Placement Details for the Schöck Isokorb® | 13 |
| Concrete Slab Construction with the Schöck Isokorb® | 18 |
| Schöck Isokorb® Cast-in-Place Reinforcement | 19 - 20 |
Typical applications for Schöck Isokorb® are cantilevered constructions such as balconies in high-rise residential buildings or canopies in institutional buildings. Solutions are available for concrete and steel structures.

**Placement details for Schöck Isokorb®**

The sample details illustrate the incorporation of Isokorb® at a typical balcony with brick cladding at the back wall and window wall. The Schöck Isokorb® is located outboard of the backup wall to avoid structural interference with the attachment of steel stud tracks or window wall deflection header. Special consideration has also been paid to allow for a practical construction detail at the Isokorb® / concrete slab interface while maintaining waterproofing continuity and serviceability by illustrating removable flashings.

The details with incorporated Schöck Isokorb® have to be approved by the engineer of record (EOR) for the slab design and the selection of the appropriate Isokorb® product.
Schöck Isokorb® Product Description and Applications
Placement details for Schöck Isokorb®

Sample detail at a typical balcony with window walls for reference purposes

Sample detail at a typical balcony with brick wall for reference purposes
**Schöck Isokorb® Product Description and Applications**

Design and materials for Schöck Isokorb®

*Schöck Isokorb® type CM: Component designations*
The Schöck Isokorb® is a load-bearing thermal break element and mainly works as follows:

1. The insulating element thermally separates the balcony slab from the interior slab and therefore reduces the thermal bridge.
2. The Schöck Isokorb® transfers the loads from the balcony slab into the interior slab.
In order to transfer the load from the balcony slab into the interior slab, the load bearing components penetrate the insulating element. The load bearing components are tension bars, shear force bars and HTE modules. Consisting of micro-steel fibre reinforced high-performance concrete, enclosed in plastic casing, the HTE modules are embedded in the insulating element. They act as a pressure bearing, and transfer the pressure force from the balcony into the interior slab.

Tension bars have a diameter of 12 mm and are held in position by the upper plastic rail. Shear force bars have a diameter of 8 mm.

The Schöck Isokorb® is available with different load bearing capacities, depending on the real loads. Load bearing capacities differ in their number of tension bars, shear force bars and HTE modules. The Schöck Isokorb® type CM is available in different heights, ranging from 180 mm to 250 mm.

The identification sticker on the top of the Schöck Isokorb® contains information about the type, the load capacity, the height, the manufacturer, and the installation leaflets, which are supplementary to the detailed installation instructions that are provided with the delivery.
Schöck Isokorb® Product Description and Applications
Materials for Schöck Isokorb® / Fire protection

Materials for Schöck Isokorb®

<table>
<thead>
<tr>
<th>Materials for Schöck Isokorb®</th>
<th>Material</th>
<th>Conforming to</th>
<th>equivalent to</th>
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<tbody>
<tr>
<td>Tension bar</td>
<td>High-yield ribbed reinforcement bar BST 500 B</td>
<td>German Standard DIN 488-1</td>
<td>CAN/CSA G30.18-M92 (R2002) ASTM A955M-96</td>
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<tr>
<td></td>
<td>Stainless steel ribbed reinforcement BST 500 A NR material no. 1.4362, minimum nominal yield strength 700MPa</td>
<td>German Standard DIN 488-1</td>
<td></td>
</tr>
<tr>
<td>Shear force bar</td>
<td>High-yield ribbed reinforcement bar BST 500 B</td>
<td>German Standard DIN 488-1</td>
<td>CAN/CSA G30.18-M92 (R2002) ASTM A955M-96</td>
</tr>
<tr>
<td></td>
<td>Stainless steel ribbed reinforcement BST 500 A NR material no. 1.4362, minimum nominal yield strength 700MPa</td>
<td>German Standard DIN 488-1</td>
<td></td>
</tr>
<tr>
<td>HTE pressure bearing</td>
<td>High-strength, fibre reinforced concrete Plastic sleeve of HD-PE plastic</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Insulation material</td>
<td>Polystyrene hard foam, k = 0.035 W/(mK)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fire protection boards</td>
<td>Lightweight building boards, material class A1 Cement bound fire safety boards, mineral wool ρ ≥150 kg/m³ Melting point T≥ 1000 °C</td>
<td>made from fibre-glass cement bonded board complying with DIN 4102-2 : 1977</td>
<td></td>
</tr>
<tr>
<td>Fire safety strips</td>
<td>made from Roku-strip</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Schöck Isokorb® fire protection

Schöck Isokorb® is available with or without fire protection. If fire safety requirements apply, CM and CV types (with HTE modules) are available in a R120 version (120 minutes fire resistance), and types CMD, CV and CEQ (without HTE modules) in a R90 version (90 minutes fire resistance). Integrated fire safety strips (type CM), made of intumescent material, and fire protection plates close the gaps opening under exposure to fire, ensuring that the Isokorb® reinforcement is protected from hot gas (see illustration); the fire protection plates protrude by 10 mm on the top of the Schöck Isokorb® types CMD, CV, CVB and CEQ. R90 resp. R120 classifications are achieved with these versions, even without additional on-site fire safety measures (e.g. mineral coating). The picture shows Schöck Isokorb® type CM in R120.
Schöck Isokorb® Product Description and Applications
Concrete slab construction with the Schöck Isokorb®

Balconies and other external structural components should be designed by the Engineer of Record (EOR) in agreement with CSA A23.3-04.

A balcony structure with Schöck Isokorb® can be supported either directly or indirectly. Direct support means that the balcony slab is connected to the interior slab, and this is supported on a wall or an interior slab joist. With indirect support the balcony slab with Schöck Isokorb® is only connected to the interior slab. Indirect support is shown here.

The following materials are assumed for the connecting components:

**Materials for connecting components**

<table>
<thead>
<tr>
<th>Materials and construction materials Connecting components</th>
<th>Material</th>
<th>Building regulations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concrete quality, interior components</td>
<td>Minimum concrete quality 25 MPa for interior components</td>
<td>CSA Standard A23.1-04</td>
</tr>
<tr>
<td>Concrete quality, exterior components</td>
<td>Minimum concrete quality 30 MPa for exterior components and class F-1 concrete</td>
<td>CSA Standard A23.1-04</td>
</tr>
</tbody>
</table>
Reinforcement for interior slab and balcony slab to be designed by the EOR of the base building.

Reinforced concrete cantilever balconies require upper and lower reinforcement and reinforcement surrounding the free borders. When using the Schöck Isokorb® the following cast-in-place reinforcement is required.

The bar lengths are designed to meet the lap splice length requirements of CSA A23.3 Cl 11.4.3.2. The standard minimum concrete cover (CC) is defined by the Schöck Isokorb® as 40 mm (alternatively 55 mm).
Please note the following for the placement of slab reinforcement with Schöck Isokorb®:

The lap splice of the Schöck Isokorb® tension and shear force bars must be provided both at the interior and the balcony side. The required lap splice reinforcement (a₁) must be at least equal to the Schöck Isokorb® reinforcement (req. a₁ ≥ exist. a₁).

Two longitudinal bars (minimum 10M) are required parallel to the insulating element at the balcony side, one bar being arranged in the upper reinforcement layer, the other in the lower.

Two longitudinal bars (minimum 10M, parallel to the insulating element) and U-bars (surrounding the free borders) are required at the interior slab.

The final reinforcement design and arrangement depends on the Isokorb® types. Please see the Isokorb® product chapters for further details.

The existing slab reinforcement can be taken into account for the required reinforcement of connections with Schöck Isokorb®.
Schöck Isokorb® Load-bearing Behavior

Contents

Load resistance and load transmission 22 - 23
Load-bearing behavior in earthquake load case 24 - 29
Deformation behavior 30 - 31
Vibration behavior 33
Behavior in the event of temperature changes -> expansion joints 34 - 36
**Schöck Isokorb® Load-bearing Behavior**

Load resistance and load transmission

**Moment transfer**
Isokorbs for cantilever balconies must be able to transfer moments and shear forces into the interior slab. The bending moment is transferred through the tension bars (top side) and the pressure bearings (bottom side), split into a pair of forces (tension and compression force). The moment results from the force $F$ multiplied by the inner lever arm $e$.

$$M = F \times e$$

The higher the Isokorb® (and the bigger the lever arm), the higher is the moment capacity. The maximum moment that can be transferred is termed as $M_r$, as per CSA A23.3-04.

**Vertical Shear transfer**
The vertical shear force is transferred into the bent corner of the tension bar. There it is split into a tension and a compression component, the tension component being transferred by the shear force bar and the compression component by the pressure bearing. The maximum possible shear force that can be transferred is termed as $V_r$, as per CSA A23.3-04.
**Schöck Isokorb® Load-bearing Behavior**

Load resistance and load transmission

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**Load distribution**

The load distribution for a balcony with a Schöck Isokorb® is determined in accordance with the National Building Code of Canada. The illustration shows an example load case for dimensioning the Schöck Isokorb®.

Dead (DL) and Live (LL) loads are computed.
Buildings in seismic zones (earthquake zones) have to resist additional loads from the earthquake. The balcony is considered to be an external component. Country-specific regulations apply to this. The earthquake load is a rare load, in which case safety reserves may be activated in the Schöck Isokorb®. The behavior of the Schöck Isokorb® type CEQ is explained in the following, which absorbs the loads from earthquakes in interaction with the Schöck Isokorb® type CM. The loads can also be absorbed in interaction with type CV and CMD, for further information please contact the Schöck Design department.

The required number of Schöck Isokorb® types CEQ is determined in accordance with the earthquake load analysis. Earthquake loads typically result in the following movements: horizontal in the direction of both building axes, upwards and downwards. The balconies follow these movements after a delay. Resulting loads are explained below.
Schöck Isokorb® Load-bearing Behavior
Load-bearing behavior in earthquake load case

Building movement direction parallel to the insulating joint: Horizontal shear force load.

The horizontal parts of the shear force are resisted by the horizontal shear force bars of the Schöck Isokorb® type CEQ and the tension bar of the Schöck Isokorb® type CM.

Movement direction parallel to insulating joint.

Schöck Isokorb®: simplified diagram of load resistance of a horizontal shear force
**Schöck Isokorb® Load-bearing Behavior**

Load-bearing behavior in earthquake load case

**Building movement direction upwards:**
**Negative moment load, positive shear force load**

This means that moment acts like a normal load, as does the shear force. The load is dissipated by the Schöck Isokorb® type CM, as described in the previous chapter.

*Schöck Isokorb*: simplified diagram of load resistance of a negative moment and a positive shear force
**Schöck Isokorb® Load-bearing Behavior**

Load-bearing behavior in earthquake load case

**Building movement direction downwards:**
Positive moment load, negative shear force load

This means that the moment acts against the normal loading of the Schöck Isokorb®. This load is absorbed by the combination of the Schöck Isokorb® type CM and the Schöck Isokorb® type CEQ. The Schöck Isokorb® type CEQ resists the bottom tensile force.
**Schöck Isokorb® Load-bearing Behavior**

Load-bearing behavior in earthquake load case

**Building movement perpendicular to the insulating joint towards the balcony: Horizontal compression load.**

The horizontal compression force is resisted by interaction of the tension bars and pressure bearings of the Schöck Isokorb® type CM and the Schöck Isokorb® type CEQ. The tension bars are relieved when this occurs.

![Movement direction perpendicular to insulating joint. Compression load](image)

![Schöck Isokorb®: simplified diagram of load resistance of horizontal compression force perpendicular to the insulating joint](image)
Schöck Isokorb® Load-bearing Behavior
Load-bearing behavior in earthquake load case

Building movement perpendicular to the insulating joint away from the balcony: Horizontal tension load.

The horizontal tensile force is dissipated by the tension bars of the Schöck Isokorb® type CEQ.
Schöck Isokorb® Load-bearing Behavior

Deflection behavior

Deformation of a balcony slab without Schöck Isokorb®

Deformation of a balcony slab with Schöck Isokorb®

Deflection

Balcony deformation is a result of loading, twisting of the interior slab and deformation of the balcony. Generally, the deformation is measured at the tip of the cantilever.

The Schöck Isokorb® is simulated by two springs, the top spring simulating the tension bar, the bottom spring simulating the HTE pressure bearing. When exposed to a bending moment, the bottom spring is compressed, and the top spring is expanded. This produces a twist angle \( \alpha \) in the Schöck Isokorb®, statically simulated by a torsion spring as illustrated.

With the Schöck Isokorb® being located between the floor slab and the balcony slab, deformation \( w_2 \) from the Schöck Isokorb® must be taken into consideration in addition to the deformation \( w_1 \) of the balcony slab. Please see the product chapters for specification of the deformation factor \( \tan \alpha \).
Schöck Isokorb® Load-bearing Behavior

Deflection behavior

In order to optimise the deformation of the balcony, the formwork can be cambered during installation. Usually, camber will be designed to counter deformation due to self weight, allowing tolerance of ± 5 mm. Drainage direction should be taken into account. Camber should be reduced for outward drainage and increased for inward drainage.

The total Camber "w" for a balcony depends on several factors:

- the amount of deformation from the angle of rotation of the interior slab
- the amount of deformation of the balcony slab,
- the amount of deformation from the Schöck Isokorb® and
- the drainage direction of the balcony.

All these points must be taken into consideration when determining the camber.
**Schöck Isokorb® Load-bearing Behavior**

Behavior in the event of temperature changes – expansion joints

*Temperature deformation and possible crack formation in a balcony slab without Schöck Isokorb®*

*Contraction of a balcony slab due to cooling, horizontal compression load on Schöck Isokorb®*

*Expansion of a balcony slab due to heating up, horizontal tension load on Schöck Isokorb®*
**Schöck Isokorb® Load-bearing Behavior**

Behavior in the event of temperature changes – expansion joints

A balcony slab expands when heated up and contracts when cooled down. With a continuous balcony slab, cracks can occur in the concrete slab due to constraint. One result can be the ingress of moisture.

The Schöck Isokorb® forms an expansion joint. The tension bars and the shear force bars in the Schöck Isokorb® repeatedly deflect slightly across their axis.

Fatigue tests were conducted for the following loads applied to the Schöck Isokorb® type CM:

1. 100 load reversals, movement distance ±2.0 mm,
2. 2000 load reversals, movement distance ±1.7 mm,
3. 20000 load reversals, movement distance ±1.1 mm.

For a symmetrical balcony slab, the tension bars and shear force bars of the Schöck Isokorb® at the edges of the balcony slab deflect more than the bars in the centre of the balcony slab.
Therefore, we recommend limiting the length of the balcony slab to a certain size, depending on the Schöck Isokorb® type. This must be verified by the EOR and adjusted if necessary.

For corner balconies, only half of the length should be used, starting from the corner.

If a balcony slab is longer, expansion joints must be provided. To form an expansion joint, the slab is cut and a Schöck dowel type ESD is arranged between the two slabs in order to prevent different slab levels.
Schöck Isokorb® Load-bearing Behavior
Vibration behavior

In the context with balconies, the term “slenderness” describes the ratio of slab thickness to cantilever length. This slenderness will influence the vibration behaviour of the balcony slab. Therefore, we recommend limiting the slenderness; for further details, please see the product chapter.
Schöck Isokorb® Installation Guidelines

Contents

| Schöck Isokorb® Installation Orientation | 39 |
| Installation | 40 - 41 |
| Installation with prefabricated floor elements or interior slab joists | 42 |
Schöck Isokorb® Installation Guidelines
Installation orientation

The Schöck Isokorb® type CM does not have a symmetrical design. Attention must therefore be paid to the installation orientation - the tension bar must be on top.

Cross-sections must be shown in the plans indicating the location and orientation of the Schöck Isokorb®.

Warning:
- Always install the Schöck Isokorb® in the correct position. The TOP part of the Schöck Isokorb® is clearly marked as such and must be visible when installation is complete.
- If the Schöck Isokorb® is reserved and instead of the marking "TOP FACE" the marking "Bottom" is visible, then danger to materials and bodily injury may result. The Schöck Isokorb® will fail and the balcony may break off.
- The tension bar must be on top when it is installed! If it is not on top, no moment can be transmitted. The balcony will no longer be able to carry the required loads and will be UNSAFE.

Schöck Isokorb® type CM: Upper tension bar moment load resistance required.

Schöck Isokorb® type CM correct installation: Tension bar on top

Schöck Isokorb® type CM wrong installation: Tension bar at bottom
Schöck Isokorb® Installation Guidelines
Installation with prefabricated floor elements or interior slab joists

The Schöck Isokorb® can be used with prefabricated or precast parts. It can be installed directly in the balcony slab in the prefabrication shop and supplied to the building site together with the concrete slab.

Force transfer from the pressure bearings into the surrounding concrete is achieved via the tight fit between the pressure bearings and the freshly poured in-situ concrete. Therefore, it must be ensured on the construction site that a casting joint of at least 50 mm is formed adjacent to the pressure bearing for type CM. A different distance may be required for other types in the Schöck Isokorb® product range. This is specified in the product chapter.

Schöck Isokorb® type CM: required casting joint installation.

Schöck Isokorb® type CM: the casting joint
For installations in cast in place concrete, please note as follows:

Arrange cast-in-place reinforcement, place Schöck Isokorb®, pour concrete, follow curing time requirements in accordance with national standards, support for an additional 28 days. It must be ensured that there is a tight fit between the pressure bearings and the freshly poured concrete! Therefore, concreting joints must be arranged below the lower edge of the Schöck Isokorb®. Detailed installation instructions for the products are shown in the installation section.
Force transfer from the pressure bearings into the surrounding concrete is achieved via the tight fit between the pressure bearings and the freshly poured in-situ concrete. Therefore, it must be ensured on the construction site that a casting joint of at least 50 mm is formed adjacent to the pressure bearing for type CM. A different distance may be required for other types in the Schöck Isokorb® product range. This is specified in the product chapter.