

DETAIL

November 2015

Your partner and specialist in thermal break technology.

Special edition:
Building with steel.



 **Schöck**
Innovative Building Solutions

Stay ahead on steel structures. The clever thermal insulation solutions.

Steel balconies connected to interior concrete slab or to steel frame are increasingly in demand in the UK and Schöck offers a number of alternative connection methods for this particular design requirement.

Balcony terraces are a key feature at Canaletto



This stunning residential tower at 257 City Road is located halfway between Old Street and Angel Stations in Islington. It comprises a 31-storey tower with 190 luxury one, two and three bedroom apartments built to the standards of Code 4 Sustainable Homes Level 4. The tower is concrete frame and has a curving facade of metal and glass that breaks the volume into a series of three-to-four storey clusters. In turn, each cluster contains grouped balcony terraces, which are a striking feature of the building. The balconies are of steel construction connected to the concrete frame. It is a high specification project and the Schöck Isokorb® type KS20 offers the ideal solution for the connection of cantilevered steel beams to reinforced concrete.



The Schöck Isokorb® type KS range for free cantilevered concrete-to-steel constructions.

Hollowcore innovation benefits PFI schemes

Two PFI Extra Care complexes are benefitting from a faster build time using innovative off-site manufacturing that combines the Schöck Isokorb® type KS14 structural thermal break units with the Hollowcore floor system. One is at Abbey Hulton village, outside Stoke-on-Trent and the other is Bluebell Park at Knowsley, Merseyside. To meet the steel cantilever requirements on the two projects the

precasters broke out selected cores and cast reinforcement bars in their works. The thermal breaks were then fixed to a template, to match the broken out Hollowcore, the complete modules then being supplied to site, dropped into position and the broken out Hollowcore filled with insitu concrete. The Hollowcore has voids extending its full length, resulting in both a huge weight saving over floor slabs of equal thickness or strength and efficiencies in transportation and material costs. The slab sizes on the Abbey Hulton and Knowsley projects are respectively 1.2m wide by 7.5m long and 1.2m x 4m long, and the Hollowcore system means they are faster to install and provide an immediate working platform for following trades.



Bluebell Park



Abbey Hulton



The Hollowcore System

Highly sustainable in its use of materials



Roseberry Park, a recent development on the previous St Luke’s Hospital site in Middlesbrough and part of the Esk & Wear Valleys NHS Trust, underwent a major £75m redevelopment to modernise the way it provides mental health and learning disability services. The hospital is spread over nearly 27,000m² of floor space and the building is designed to be highly sustainable in both its materials and use of energy. To prevent solar gain inside the building, the south aspect features an extensive brise soleil which is connected to the steel frame. An effective thermal break is critical and the Schöck Isokorb® type KST for steel-to-steel connectivity sits between the outer and inner structural connection points and blocks the outflow of heat through the use of stainless steel and high quality polystyrene insulation foam. Its modular design means that the system can be used for connections with all profile sizes and structural loads.



The Schöck Isokorb® type KST range for steel-to-steel constructions.

Designed to integrate with the townscape



The regeneration of the Kings Crescent Estate in Hackney seeks to reintegrate the estate with its surrounding townscape. The three new buildings, varying from five to twelve storeys, are designed to integrate with the Victorian townscape of close by Clissold Park and other surrounding 19th century housing. High quality brick materials with considered detailing means that the buildings sit comfortably in that context and robust materials such as solid timber are used in areas such as entrances and balconies. The five-year masterplan is to provide 765 units of various tenure and the first phase will provide 273 units with space for a community centre and retail units at ground floor level. To prevent the possibility of thermal bridging at the balcony connectivity points, the Schöck Isokorb® type QS is installed. It transfers positive shear forces for connections involving supported steel beams to reinforced concrete and is used widely throughout the development.



The Schöck Isokorb® type QS range for supported concrete-to-steel constructions.

Keeping thermal bridges and vibrations in steel balconies safely under control.



Architects and structural engineers need to consider a whole host of influencing variables in the development and structural design of steel balconies to make sure the solution is both safe and efficient. When selecting the method of connection to the building slab, the challenge lies in choosing a component that will ensure both an effective thermal break and a structural and design solution that is safe – and all still compliant with the necessary verification requirements.

Generally speaking, lightweight support structures, such as free cantilevered steel balconies, are particularly prone to impermissible vibration when people start to walk, rock about or jump around on them. As designs become ever more lightweight and competitive in terms of total cost, the vibration behaviour of a structure is gaining in importance.

Construction practitioners repeatedly voice their concern that thermally effective insulating elements, such as the Schöck Isokorb® type KS, make balconies more prone to vibration, while steel balconies connected conventionally with simple pads are more rigid and less susceptible.

Thermally effective connections, such as the Schöck Isokorb® type KS, are indeed "softer" than traditional connections, due to their material properties. And yet – if planned properly – virtually any balcony geometry can be designed without constraints using Schöck Isokorb® type KS.

Acceptability of vibrations

Part L defines the limit values for thermal bridges, whereas Eurocode 3 specifies the required verifications, such as vibration, in serviceability limit state. Such verification is usually provided by calculating the natural frequency of the construction. The structural engineer specifies the limit frequency, depending on the utilisation of the structure. Ultimately, the design of the balcony construction and thermal insulating element must ensure that the natural frequency is greater than the limit frequency specified by the structural engineer.

Generally, vibration of floors is considered to be a serviceability issue, primarily related to discomfort, although vibration can also cause minor damage or cracks and can affect sensitive equipment. However, discomfort cannot directly be quantified or scaled. As perception and discomfort vary between humans, no exact limit can be imposed that will guarantee that the structure response will not give rise to adverse comments from occupants throughout its lifetime of use.

Assessment of vibration is therefore not straightforward, but a reasonable and simplified approach is to design structures so that their natural frequency is sufficiently far removed from potential excitation frequencies.

Depending on the type and utilisation of the structure, trade literature indicates limit frequencies of between 4 and 7.5 Hz. Experience has shown that taking a limit frequency of 7.5 Hz for steel balconies not only eliminates the possibility of impermissible vibration; it also enables the design of cost efficient structures.

The first natural frequency can thus be calculated for a cantilever beam as follows.

$$f = \frac{1}{2\pi} \cdot \sqrt{\frac{k_{ges}}{m_{ges}}}$$

The calculation produces the total spring stiffness k_{ges} from the distortion of the connection and as a result of the bending curve of the balcony construction. The total mass $m_{ges} = m_g + m_q$ results from the dead load of the construction (steel beam, covering layer, railing etc.) and the percentage of live load to be expected. This share is assumed to be 30% of the total live load, corresponding to the quasi-permanent load combination used for the serviceability limit state design situation.

Natural frequencies of steel balconies thermally broken by Schöck Isokorb® types KS

Schöck Isokorb® type KS for concrete-steel connections is a thermal element with 80mm insulation that ensures effective thermal breaks. The component can be pre-fabricated to a large degree at the steelworks, thus reducing the time needed to assemble on site to a minimum. Since it can bear heavy loads, it can be easily used to resolve the technical and structural issues of designing modern balconies. Normally, the elements are exposed to dead loads, and transfer moments, shear forces and horizontal forces parallel to the edge of the slab in the case of cantilever steel balconies with thermally broken connection to a concrete slab. The element is 180 mm wide. It is between 180 and 280mm high for flexible adjustment to differing slab thicknesses. The insulating layer is 80 mm thick.

In order to assess how prone balconies with thermal separation provided by Schöck Isokorb® type KS are to vibration, the natural frequencies of the structures were calculated under consideration of numerous geometric and material variables.

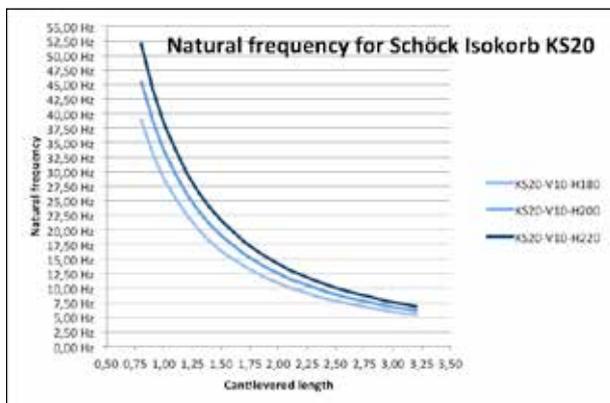


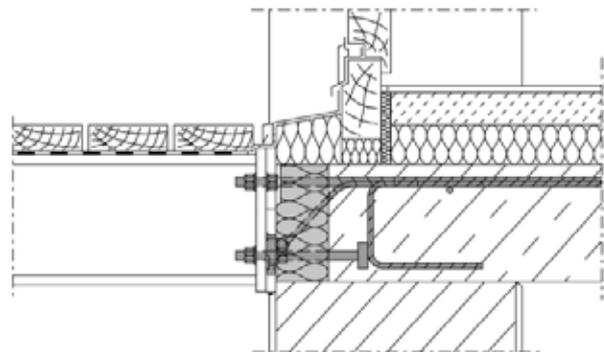
Fig. 1: Natural frequencies of steel balconies with thermal separation provided by Schöck Isokorb® type KS20, calculated for various cantilever lengths and specific load assumptions.

The result: The natural frequencies of normal balcony constructions are still above the recommended limit frequencies, even when using and considering Schöck Isokorb® type KS.

Recommendations for planning and designing steel balconies

The following parameters influence the natural frequency and, as such, the vibration behaviour of free cantilever steel balconies. Particular attention should therefore be paid to them when planning and designing thermally broken steel balconies:

- Balcony geometry, especially the cantilever length and spacing between the connections
- Rigidity and proper execution of the stub bracket, especially on stepped thresholds
- Sufficient transverse rigidity of the balcony construction
- Incorporation of the stiffness of the chosen thermal insulating element into the planning process



Schöck can help with vibration analysis, and offers a comprehensive service portfolio to support proper and safe planning of thermally broken steel balconies. A team of engineers equipped with calculation programs and technical literature is available to answer questions.

Outdoors is an inner courtyard. Schöck Isokorb® type KS.

Outdoor life tends to take place inside the perimeter of block buildings in towns and cities. An inner courtyard becomes the outdoor area of choice, shielded from the noise from the roads that surround the building. The Wright Place project involved the installation of 60 balconies that were also planned as design elements. Schöck Isokorb® was used for both structural stability and thermal insulation.



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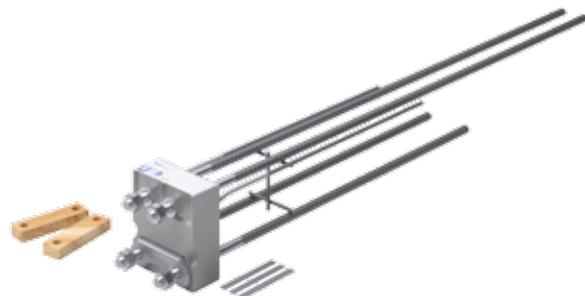
Turning block perimeters into something very special

Although architects matti ragaz hitz originally designed the residential and commercial complex housing offices, retail units and warehousing space as a conventional block perimeter building, they have since been continuously modifying it by adding bits and taking bits away. Their approach is to use different building heights and depths, and to break up the block with larger "landscape windows" that can extend over as many as two floors. They are also creating an attractive outdoor area by using balconies, patios and rooftop areas to enliven the courtyard. These details turn the otherwise monotonous block perimeter design into a delicate pattern of interlocking buildings that is brought to life by the interaction between indoors and outdoors, protrusions and recesses. This dynamic impression is also reflected by the irregular arrangement of the balconies.

Precast balconies as design elements

A total of 300 Schöck Isokorb® elements – between four and six per balcony, depending on size – were installed in the building structure, with some welded to the reinforcement to prevent tipping during

concrete application. The Isokorb® used was type KS from Schöck's standard range, which functions as a load bearing thermal insulation element, eliminating thermal bridges between reinforced concrete and steel structures and thus preventing mould formation at the critical joints. The Schöck Isokorb® allows steel and metalworkers to prefabricate to a large degree, thus reducing installation times to a minimum. Its superb load bearing capacity offers enormous scope for balcony design while ensuring outstanding structural stability.



Schöck Isokorb® type KS was used as the thermal insulation to minimise thermal bridges on balconies and prevent mould forming in the interior. The load bearing thermal insulation element for connecting free cantilever steel supports to reinforced concrete inner slabs can support heavy loads, offers huge scope for balcony design, and is an outstanding solution in terms of structural stability.

By contrast, the 60 balconies that the metalworker prefabricated completely, based on the architects' plans, using sheet aluminium, Mineralit, stainless steel and laminated safety glass were anything but a standard solution. To mount them on the finished facade, they were lifted into the courtyard and brought



The Schöck Isokorb® elements, a total of 300 – between four and six per balcony, depending on size – were installed while the structure was being built, with some welded to the reinforcement to prevent tipping during concrete application.

into position by a crane fitted with lifting gear designed specifically for the purpose. The pre-stressed screw connections were then tightened to the manufacturer's exact specifications using a torque wrench, before being tested by an engineering firm engaged by the general contractor.



The metalworker completely prefabricated the balconies, based on the architects' plans, using sheet aluminium, Mineralit, stainless steel and laminated safety glass. The balconies were lifted into place by a crane fitted with special lifting gear.

Schöck is moving to Bicester...

As the Schöck operation in the UK continues to see rapid expansion, our need for much larger modern premises has grown too. And by the end of November, we will have relocated to a new self-contained office block in Bicester. The new offices will provide a first class working environment for our various teams and offer the capacity to accommodate continued growth for the foreseeable future. Our intention is to remain at the forefront of thermal break technology in the UK; and to

underpin this ambition one of our initiatives is to establish a 'centre for learning' at the new location. The town of Bicester fittingly has some of the highest eco-credentials in the country and is soon to be further developed as Britain's second new garden city. From a travel perspective it is strategically situated close to the M40 motorway and the new Bicester Parkway Station has direct links into London and the Midlands.

Schöck prevents thermal bridging in new distillery. Schöck Isokorb® type KST.



Middleton - one of the most modern distilleries in the world.

Marketing and distribution across Ireland of the major Pernod Ricard premium wine and spirit brands, such as Malibu; Jacob's Creek; Brancott Estate and Mumm; is big business for Irish Distillers Pernod Ricard. However, the company's real heritage is in its whiskey brands, particularly Jameson Irish Whiskey, which is produced at the main distillery in Middleton, County Cork. The site has a production capacity of 33 million litres of alcohol a year, but even this is still insufficient to meet increasing international demand. As a result, €100 million has been invested in new plant to double the capacity, making Middleton one of the most modern distilleries in the world. It boasts three 75,000 litre pot stills, and three column stills, which are used in combinations of three to produce the different types of whiskey.

Sustainability has always played a significant part in Irish Distillers Pernod Ricard's development programmes and the new expansion is no exception. "Sustainability was a pre-requisite from the outset, from the design stage. Every element was examined from a sustainability perspective", says Tommy Keane, head of distilling operations at Irish Distillers. A challenge taken up by the architect John Morehead, of Wain Morehead Architects, who comments: "We were able to incorporate all the tools and techniques we used from doing passivhaus buildings and apply it to this building".

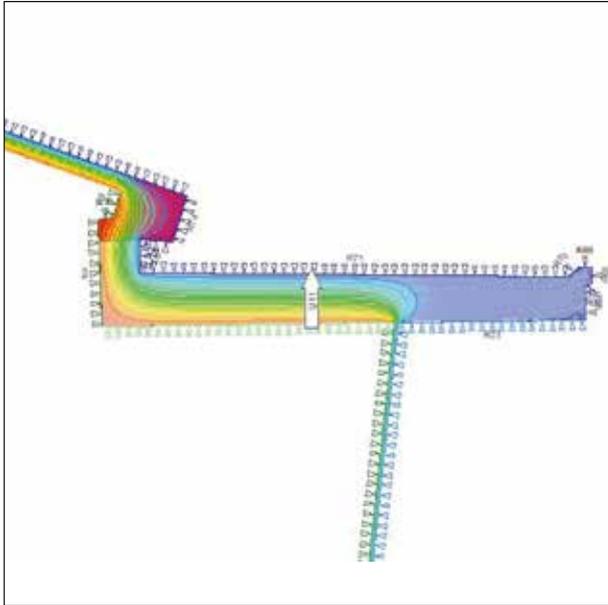
The 21.5m high pot still hall building envelope is designed to a very high level of thermal performance and one of the design factors that had to be taken into account was the prevention of thermal bridging.

There is of course a regulatory need to reduce local heat loss and CO2 emissions. But in addition, condensation can be a potential problem too, frequently resulting in structural integrity problems – and even mould growth, which brings its own set of health risks to personnel. The pot still hall has an overhanging roof element and this is insulated to the top, leading edge and underside on the north elevation and part return on the east and west elevations over a glazed wall. To prevent any risk of thermal bridging at these roof overhang connectivity points, the structural elements to the primary steel are isolated from the interior environment using Isokorb® structural thermal break units from Schöck.

The Schöck Isokorb® is one of the most sophisticated solutions on the market, for the prevention of thermal bridging in connective situations; and has been supplied for the project by Contech Accessories, of Tullow, County Carlow, the Schöck sales partner and sole distributor for Ireland.



Schöck Isokorb® type KST modules in position.



Heat flow line.

The Schöck Isokorb® offers outstanding thermal efficiency and unrivalled application options, allowing connections to be made between concrete-to-concrete, concrete-to-steel and steel-to-steel. One of the modular connection types even allows the retro-fitting of balconies in certain situations. At Middleton, it is the KST-QST module for steel-to-steel applications that has been specified. The KST modules are unique in being able to withstand extremely demanding loads and incorporate stainless steel components to ensure

corrosion protection and minimise thermal conductivity. Due to their thermal insulation properties, the Schöck Isokorb® modules dramatically reduce energy loss in connective areas by guaranteeing that there is uniformity between cantilever structures and the internal structure at the thermal envelope. They also transfer load and maintain full structural integrity, while at the same time enabling inner surface area temperatures to remain well in excess of those likely to cause mould formation and condensation. The units are easy to fit with regular end-plate connections and all available steel profiles can be bolted on.

The entire Schöck Isokorb® range provides BBA Certification and LABC Registration, and comfortably exceeds the requirements of BRE IP1/06 and Part L of the UK and Irish Building Regulations. These state that the temperature factor used to indicate condensation risk (fRSI), must be greater than, or equal to, 0.50 for commercial buildings, a requirement comfortably exceeded by incorporating the Schöck Isokorb® into the design.

There is also compliance with the Government Standard Assessment Procedure, SAP 2009, concerning CO2 emissions from buildings, and respectively heat losses through non-repeating thermal bridges. Here, the lambda values of the Schöck Isokorb® enables energy loss through balconies, canopies and other cantilever parts of the building to be reduced by as much as 84% to 91%.

Your thermal break technology contact.

Key Account Manager role focuses on steel connectivity

Simon Hill has been appointed to the newly created position of Key Account Manager at Schöck. The UK market potential for steel connectivity applications is growing at pace and as the recognised leading supplier of thermal breaks to this sector; we have an obligation to offer the best possible service levels to our customer base. Simon will therefore be responsible for project managing all steel balcony, Brise Soleil and canopy enquiries involving the Schöck Isokorb® types KS, QS and KST product groups. Primarily this will mean the coordination of all key project development and application

opportunities involving specifiers, developers, main contractors, balcony suppliers, fabricators and framework contractors. In addition, Simon will provide regular training and updates to colleagues so that any current issues relating to his product groups are communicated throughout the organisation. Simon, who was previously a Regional Sales Manager for Schöck has a B.Eng (Hons) degree in Civil Engineering from the University of Liverpool and comments: “With my engineering and commercial experience gained across a wide range of construction industry sectors – including concrete, timber and steel – I like to think that this is a good combination of skills to bring to the role”.

Guidelines for the selection and use of structural thermal breaks in steel balconies.

The following article provides background information which are important to accurately select structural thermal breaks in steel balconies. Due to the function and construction method of structural thermal breaks there are specific characteristics which need to be assessed and which can only be verified by large scale testing and/or 3D analyses.

Use and function of thermal breaks

Manufactured structural thermal breaks are selected in order to

1. Minimize the thermal bridges in buildings
2. Maintain full structural integrity of the connection
3. Ensure any specific fire regulations are met

Construction methods of thermal breaks

In relation to the intended use of thermal break element, the main body is made up of, in particular, the following components

- thermal insulation with a certain minimum thickness
- load-bearing components, including stainless steel, common reinforcing steel and concrete bearing to transfer compression forces (including any weldings)
- fire protection boards

Assessment of the key characteristics.

The assessment methods below should take into account a working life of the thermal break for a defined intended use when installed in the works. For balconies, in the UK the NHBC is requiring a life time of at least 60 years.

1. Mechanical resistance and stability

- Load bearing capacity, stiffness and deformation calculations shall be carried out in accordance with UK Building Regulations and are to be verified in large scale testings
- Thermal Actions
The lateral displacement of the exterior balcony due to temperature changes shall be tested in large scale test with cyclic lateral displacement. To determine the displacement the permitted distance of the joints has to assumed. The tested lateral cyclic displacements correspond to a defined temperature spectrum
- Durability
The steel passing through the thermal insulation material shall have an appropriate corrosion protection which is ensured by either stainless steel or a sleeve in stainless around the steel

2. Fire Assessments

The load bearing thermal insulation element shall be tested, using the test methods relevant for the corresponding reaction to fire class, in order to be classified according to EN 13501-1. This only can be verified by testings.

3. Thermal Assessments

According UK Building Regulations Part L junction temperature factors, and hence risk of surface condensation, have to be assessed in accordance with section 7.1 and BRE Information Paper IP 01/06. The minimum temperature factor for junction details eg in dwellings and residential buildings is set at $f_{RSi} = 0.75$. This only can be verified by 3D thermal analyses.

Verified structural performance and quality of Schöck Isokorb®



The conformity of Schöck Isokorb® to UK Building Regulations and to the specifics of manufactured structural thermal breaks is independently verified by BBA.

The BBA is the UK's major authority offering approval and certification services to manufacturers and installers supplying the construction industry.

BBA Approval is recognised by building control, government departments, architects, local authorities, specifiers, and industry insurers like the NHBC, and complement manufacturers own technical data with the BBAs impartial and unbiased information on the performance of the product. The BBA also works closely with regulatory authorities throughout the UK as well, as with housing warranty bodies, to ensure Agrément Certificates are accepted nationwide.

The BBA assessment shows that Schöck Isokorb® provides

- verified thermal actions considering a working life of minimum 60 years by large scale testings
- verified durability of the materials used
- verified fire protection - Test results have indicated that the products incorporating the fire protection plates are capable of achieving up to 120 minutes loadbearing capacity, 120 minutes integrity and 120 minutes insulation
- verified material and product quality according BBA approval by internal and external quality control

Verified thermal performance of Schöck Isokorb®



To guarantee the accuracy of its current performance values, Schöck has submitted its solutions for independent evaluation by the Oxford Institute for Sustainable Development (OISD), at Oxford Brookes University. One of the UK's largest research institutes dedicated to sustainable development research in the built and natural environments. The results show that Schöck Isokorb® in general provides verifiable thermal performance and compliance with UK Building Regulations Part L.



Schöck Isokorb® type KS



Schöck Isokorb® type KST

Forum "Gold und Silber" with its impressively unusual facade incorporating a thermally separated steel structure.

The flowers and shrubs from last year's State Garden Show in Schwäbisch Gmünd have long since withered, whereas the Forum "Gold und Silber" that was opened for the occasion is as magnificent as ever and still serving as a semi-public building with catering, office and surgery facilities. The unusual facade with its warm golden colouring and square cut-outs is fastened to a steel substructure that, in turn, is anchored to the reinforced concrete building with Isokorb® types KS and K.



Separating the core from the envelope

The design of the magnificent envelope made from aluminium slabs with gold-coloured coating is testament to the goldsmithing that has been a traditional craft in Schwäbisch Gmünd for more than six hundred years. The sculptural edifice was designed by Isin & Co. a firm of architects and general planners with offices in Aalen, Stuttgart and Schwäbisch Gmünd. Their concept envisaged strict separation of the core from the envelope:

A multi-angled lightweight structure made of square façade panels coated with a substance that is reminiscent of gold leaf encases the five-floor reinforced concrete skeleton structure measuring 19 x 19 metres. The aluminium skin is set at a distance and features more than 1000 cut-outs of various sizes at interestingly different intervals. Like flaws in a panelled surface, they reveal glimpses of the building concealed behind.

Getting a grip on thermal bridges

The aluminium panels are fastened to a steel frame anchored with type KS Schöck Isokorb® elements to

the load-bearing reinforced concrete skeleton structure. In addition, type K Isokorb® elements transfer the loads from cantilevered concrete slabs into the concrete structure. Without these load bearing thermal insulation elements, it would not be possible to implement such a facade design nowadays, given the thermal bridges at the joints. Schöck Isokorb® type KS transfers negative moments and positive shear forces from steel components, such as cantilevered facade substructures, balconies and canopies, to concrete components. Whereas Schöck Isokorb® type K is designed for cantilever reinforced concrete balconies and concrete slabs. This Schöck Isokorb® variant also transfers negative moments and positive shear forces.

Modern precious metal design

Accordingly the Schöck Isokorb® plays a key role in enabling implementation of the unusual facade design, which turns the building into a striking statement of modern architecture. A total of 767 aluminium panels were used. Their unmistakable, warm golden colouring comes from Duraflon coating, which is enormously resistant to bleaching and colour changes. Depending on the angle of the sun and the position of the observer, the Swabian nugget on the banks of the River Rems shimmers in different shades of metallic gold, while at the same time proving "all that glitters is not gold". Nevertheless, the Forum Gold und Silber still knows how to impress, long after the State Garden Show has finished.

Construction site sign

Completion:	2014
Builders:	Gerhard Grimminger, Cemal Isin, Edelmetallverband e. V.
Architect and general planner:	ISIN + CO GmbH & Co. KG
Schöck products:	Schöck Isokorb® type KS Schöck Isokorb® type K

New Specification Engineer role at Schöck.



Chirag Patel has been appointed to the newly created position of Specification Engineer at Schöck. In this role, designed to enhance the already extensive technical team support available from the

company, Chirag will provide technical guidance and assistance to specifiers, structural engineers and other users in the design principles and most effective use of Schöck structural thermal break elements. This is through a combination of direct contact and use of the advanced software available from the company.

It is part of the Schöck ethos that customer satisfaction plays a key role in the company's behaviour and this applies as much to developing services as it does to developing products. By necessity the engineers in the technical team are primarily project orientated, working closely with clients on specific day-to-day issues. However, it is recognised that there is scope for a role with a broader more 'educative' approach, placing greater emphasis on the general principles of thermal break issues and good design practice

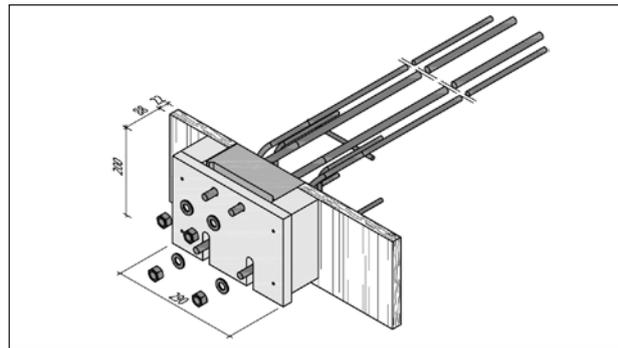
As a result, In addition to providing expert advice, Chirag will offer lecturing and training sessions, including advanced CPD seminars, with the purpose of ensuring safe in-house project design for a wide variety of users.

Schöck Isokorb® type KS installation jig. Safe and fast installation on site.

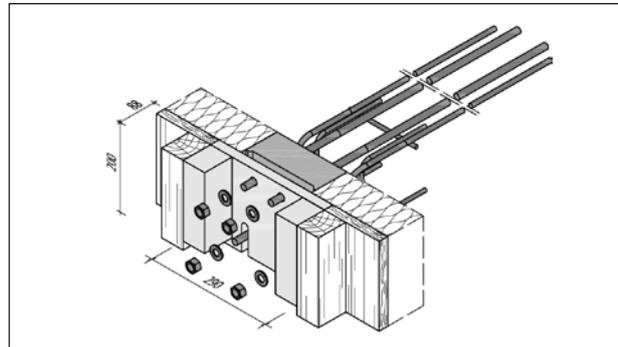
The new Schöck Isokorb® type KS installation jig gives you the reassurance that the Schöck Isokorb® type KS is correctly seated both before and while applying the concrete, thus improving installation accuracy. Schöck Isokorb® type KS installation aid is available in 2 different variants (KS14 H180-220 and KS20 H180-220) and can be used on EITCS or for monolithic wall structures. The installation aid can also be used together with Schöck Isokorb® type QS.



Schöck Isokorb® type KS installation jig.

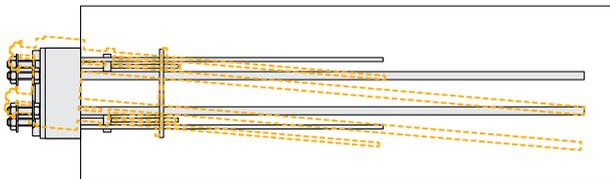


EITCS wall structure

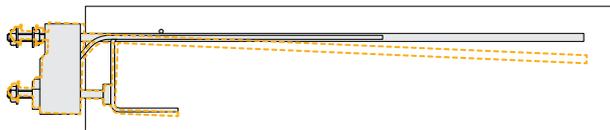


Monolithic wall structure

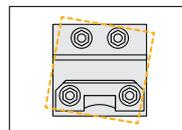
Schöck recommend using a template to ensure accuracy of the Isokorb® type KS installation. Using a template (Schöck or supplied by others) should help avoid:



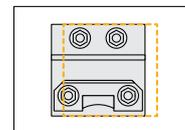
Twist on plan.



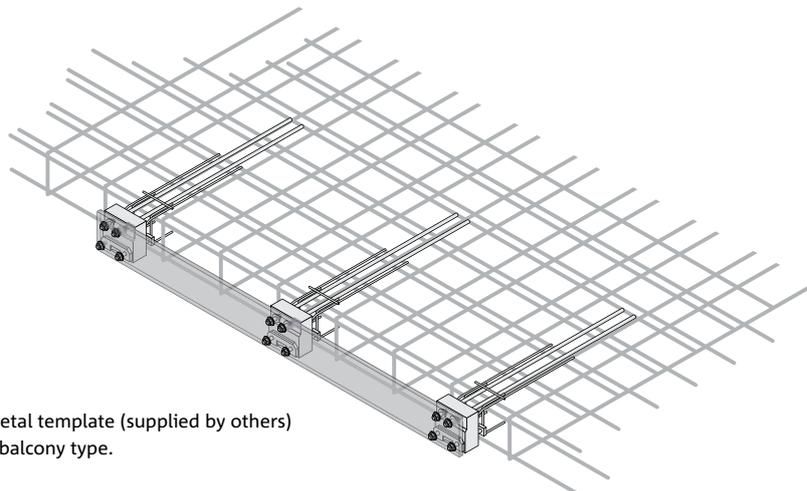
Twist and level in section.



Twist on elevation.



Twist on location.



Timber or metal template (supplied by others) to suit each balcony type.

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