Schöck Isokorb® Type S22 and S16

Figure 1. Schöck Isokorb® Type S22

The Schöck Isokorb® Type S22 and S16 is used to transmit axial and shear forces in a steel connection. The combination of multiple modules can be used to resist moment forces in a steel connection.

This design methodology has been approved under the German technical authority DIBT as National Technical Approval No. Z-14.4-518. It has been reviewed based on the American National Standard ANSI/AISC 360-16 "Specification for Structural Steel buildings" published by the American National Standards Institute (ANSI) and the American Institute of Steel Construction (AISC).

Product Description. The Schöck Isokorb® for steel connection module is used to resist compression, tension and shear forces. Modules acting together in tandem can resist moment forces for a cantilevered beam connection.

This product comes in two variants: S16 and S22. The 16 and 22 refer to the size of the stainless-steel bolts provided in each product, M16 and M22 respectively. In addition to the bolts there is a stainless-steel HSS that provides rigidity to the product to help resist shear forces. Two end plates make up the remainder of the product structure. The structural portion of the module is surrounded in a Neopor insulation block to complete the product.

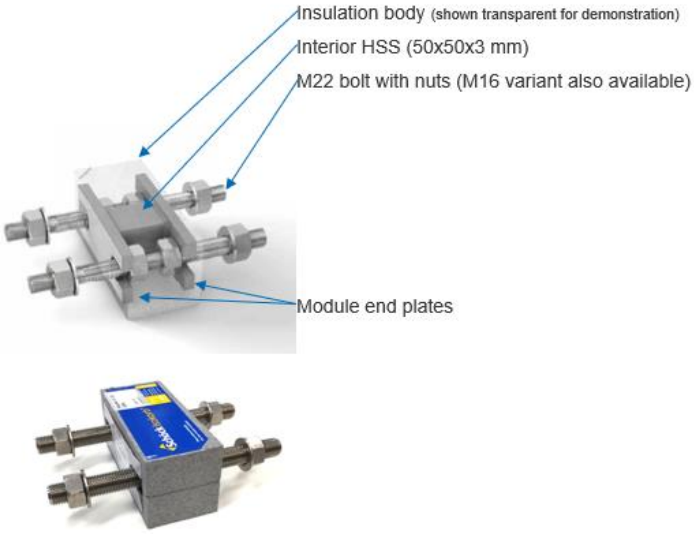

Figure 2. Description of Isokorb® Components

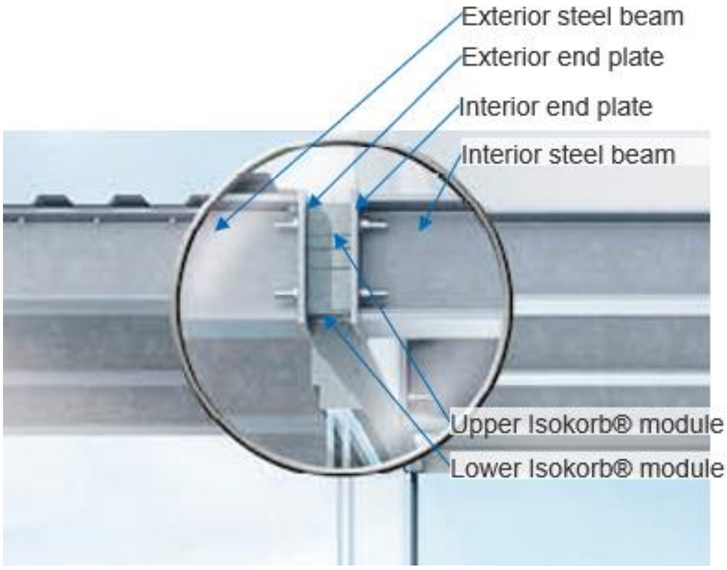

Figure 3. Description of Thermal Break Connection

Structural Material Specifications

Item	EU Class	Nominal Strength	Material No.	Comparable Alloy
M16 bolts	70	800 MPa (116 ksi)	1.4462	ASTM A240 Duplex 2507
M22 bolts	70	800 MPa (116 ksi)	1.4462	ASTM A240 Duplex 2507
HSS (50x50x3mm)	S355	550 MPa (80 ksi)	1.4571	ASTM A240 Grade 316 Ti
Module end plates (t=12mm)	S235	500 MPa (72 ksi)	1.4401	ASTM A240 Grade 316

Table 1. Material Properties

Notes on Capacity Calculations:

The Schöck Isokorb® steel connection modules are for static loading only with no torsion forces passing through the connection. Rigid end-plates are assumed for the beam at the thermal break connection.

Calculation of shear resistance depends on the compression/tension in the module bolts. There are three possible conditions:

- Bolts in compression zone: both bolts are in compression
- Bolts in compression/tension combination zone: one bolt is in compression and the other is in tension
- Bolts in tension zone: both bolts are in tension

The design rules for the allocation of shear demand to connection modules have been developed through physical trials and testing. The allocation of shear demand to modules may be distributed to the according to the maximum shear strength of each modules provided the following conditions are met:

- The applied shear forces $V_{u,y}$ and $V_{u,z}$ are allocated to all modules proportionally (figure 5), so the following holds for all modules:
  $V_{u,i,y} / V_{u,i,z} = const.$ i = 1, 2, … number of modules
- The distribution of shear demand is symmetrical about the z-axis.
- The sum of the shear force components of the individual modules corresponds to the total shear force acting on the connections.

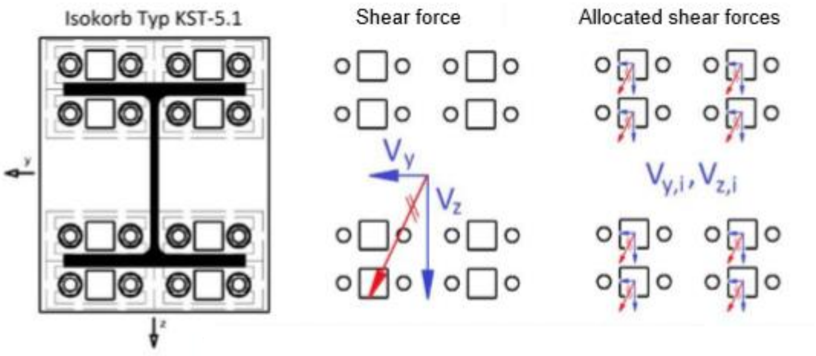

Figure 4. Allocation of Shear Demand to Modules

Notes on nomenclature: subscript Ed stands for factored loading imposed on the connection and the subscript Rd stands for the resistance provided by the module or bolts. The table below describes the European terms provided in this manual in their equivalent American form:

Z-14.4-518	ANSI/AISC 360-16	Description
Z_{Ed}	T_u	Factored tension force in bolt under consideration
D_{Ed}	C_u	Factored compression force in bolt under consideration
$C_{ZD,Rd}$	T_u	Factored tension force in element under consideration
$C_{VZ,Rd}$	$\phi V_{n,T}$	Max shear resistance when module is in tension
$C_{VD,Rd}$	$\phi V_{n,C}$	Max shear resistance when module is in compression
$V_{y,I,Ed}$	$V_{i,u,y}$	Factored horizontal shear in module under consideration
$V_{z,I,Ed}$	$V_{i,u,z}$	Factored vertical shear in module under consideration
$V_{z,Rd}$	$\phi V_{n,z}$	Vertical shear resistance of module
$V_{y,Rd}$	$\phi V_{n,y}$	Horizontal shear resistance of module
$M_{z,Ed}$	$M_{u,z}$	Factored moments about z-axis
$M_{z,Rd}$	$\phi M_{n,z}$	Factored resistance about z-axis
N_{Ed}	P_u	Factored axial forces
$N_{GS,Ed}$	$P_{u,bolt}$	Factored axial forces in bolts determined by statics
N_{Rd}	$\phi P_{n,\ bolt}$	Factored axial resistance of bolt

Table 2. Nomenclature

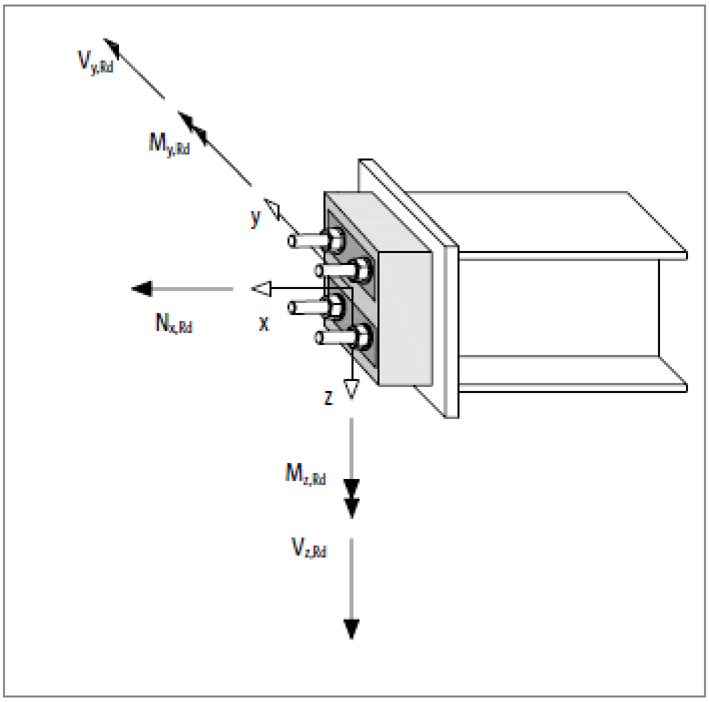

Figure 5. Sign Convention for Structural System

Overview: Structural Cases

Case 1. Supported Steel Connection with Vertical Shear ±V_z, Horizontal Shear ±V_y and Axial Forces ±P_x only, with one connecting module. (page 6)

Case 2. Cantilevered Steel Connection with Vertical Shear ±V_z, Horizontal Shear ±V_y and Axial Forces ±P_x, and Moments in the vertical and horizontal planes ±M_y and ±M_z with multiple connecting modules in tandem. (page 7)

Case 3. Cantilevered Steel Connection with Vertical Shear ±V_z, Horizontal Shear ±V_y and Axial Forces ±P_x, and Moments in the vertical and horizontal planes ±M_y and ±M_z with multiple connecting modules. (page 9)

Case 1. Supported Steel Connection with Vertical Shear $\pm V_z$, Horizontal Shear $\pm V_y$ and Axial Forces $\pm P_x$ only, with one connecting module.

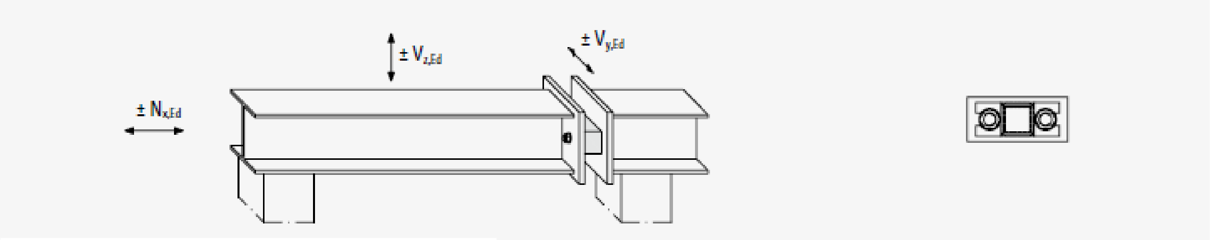

Figure 6. Case 1: Supported Steel Connection

Schöck Isokorb® Module	**S16**			**S22**		
Capacity calculation per:	ϕP_n [kip/Module]					
Module	±26.3			±50.7		
	Shear Resistance for Compression Case					
Module	$\phi V_{n,z}$ [kip/Module]					
	for:	$0 \leq \lvert V_{u,y} \rvert \leq 1.3$	±6.7	for:	$0 \leq \lvert V_{u,y} \rvert \leq 1.3$	±8.1
		$1.3 \leq \lvert V_{u,y} \rvert \leq 3.4$	$\pm(6.7 - \lvert V_{u,y} \rvert)$		$1.3 \leq \lvert V_{u,y} \rvert \leq 4.0$	$\pm(8.1 - \lvert V_{u,y} \rvert)$
	$\phi V_{n,y}$ [kip/Module]					
	$\pm\min\{3.4; (6.7 - \lvert V_{u,z} \rvert)\}$			$\pm\min\{4.0; (8.1 - \lvert V_{u,z} \rvert)\}$		
	Shear Resistance for Tension Case					
Module	$\phi V_{n,z}$ [kip/Module]					
	for:	$0 \leq P_{u,x} \leq 6.0$	$\pm(6.7 - \lvert V_{u,y} \rvert)$	for:	$0 \leq P_{u,x} \leq 26.4$	$\pm(8.1 - \lvert V_{u,y} \rvert)$
		$6.0 \leq P_{u,x} \leq 26.3$	$\pm(⅓*(26.3 - P_{u,x}) - \lvert V_{u,y} \rvert)$		$26.4 \leq P_{u,x} \leq 50.7$	$\pm(⅓*(50.7 - P_{u,x}) - \lvert V_{u,y} \rvert)$
	$\phi V_{n,y}$ [kip/Module]					
	for:	$0 \leq P_{u,x} \leq 6.0$	$\pm\min\{3.4; (6.7 - \lvert V_{u,z} \rvert)$	for:	$0 \leq P_{u,x} \leq 26.4$	$\pm\min\{4.0; (8.1 - \lvert V_{u,z} \rvert)$
		$6.0 \leq P_{u,x} \leq 26.3$	$\pm\min\{3.4; ⅓*(26.3 - P_{u,x}) - \lvert V_{u,z} \rvert)$		$26.4 \leq P_{u,x} \leq 50.7$	$\pm\min\{4.0; ⅓*(50.7 - P_{u,x}) - \lvert V_{u,z} \rvert)$

Table 3. Case 1 Axial and Shear Capacity

Case 2. Cantilevered Steel Connection with Vertical Shear ±V_z, Horizontal Shear ±V_y and Axial Forces ±P_x, and Moments in the vertical and horizontal planes ±M_y and ±M_z with multiple connecting modules in tandem.

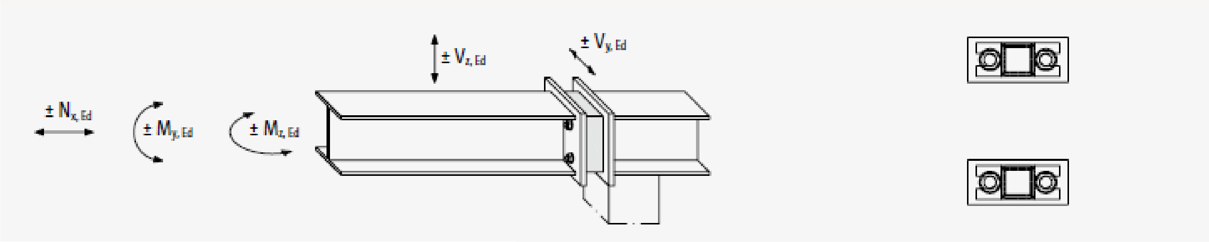

Figure 7. Case 2: Simple Cantilevered Steel Connection

Axial resistance per bolt

Schöck Isokorb® Module	S16	S22
Axial Capacity per:	$\phi P_{n,\,bolt}$ [kip/Bolt]	
Bolt	±13.1	±25.3
	$\phi P_{n,\,bolt,\,Mz}$ [kip/Bolt]	
Bolt	±6.6	±12.7

Table 4. Case 2 Axial Capacity

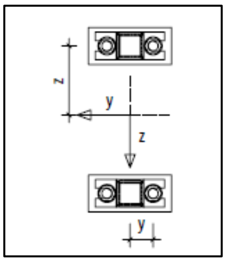

Figure 8. Case 2: Module Lever Arms

Note: The tension/compression capacity of the bolt is reduced under moment about the z-axis to ensure that adequate shear strength in the y-direction is obtained.

Axial forces in the bolts can be combined with the lever arm to resist moment forces in the connection. $+\phi P_{n,\,bolt}$ is considered a bolt in tension and $-\phi P_{n,\,bolt}$ is considered a bolt in compression.

Force Components:

- Axial force $P_{u,x}$ — $P_{1,u,bolt} = P_{u,x}/4$
- Moment about y-axis $M_{u,y}$ — $P_{2,u,bolt} = M_{u,y}/(4*z)$
- Moment about z-axis $M_{u,z}$ — $P_{3,u,bolt} = M_{u,z}/(4*y)$

Check required of conditions of bi-axial moment and axial force combinations:

- Condition 1: Bi-axial moment check combined with axial force:

  $|P_{1,u,bolt} + P_{2,u,bolt} + P_{3,u,bolt}| \leq |\phi P_{n,\,bolt}|$ [kip/Bolt]

  The maximum or minimum loaded bolt is the governing case

- Condition 2: Axial force combined with minor (z-axis) moment:

  $|P_{1,u,bolt} + P_{3,u,bolt}| \leq |\phi P_{n,\,bolt,\,Mz}|$ [kip/Bolt]

Case 2. Continued

Shear resistance per module and per connection

<table>
<tr><th>Schöck Isokorb® Module</th><th colspan="3">S16</th><th colspan="3">S22</th></tr>
<tr><td>Capacity per:</td><td colspan="6">Shear Resistance for Compression Zone</td></tr>
<tr><td rowspan="4">Module</td><td colspan="6">$\phi V_{i,n,z}$ [kip/Module]</td></tr>
<tr><td colspan="3">$\pm(10.3 - |V_{i,u,y}|)$</td><td colspan="3">$\pm(11.2 - |V_{i,u,y}|)$</td></tr>
<tr><td colspan="6">$\phi V_{1,n,y}$ [kip/Module]</td></tr>
<tr><td colspan="3">$\pm\min\{5.2; (10.3 - |V_{i,u,z}|)\}$</td><td colspan="3">$\pm\min\{5.6; (11.2 - |V_{i,u,z}|)\}$</td></tr>
<tr><td></td><td colspan="6">Shear Resistance for Tension/Compression Zone and Tension Zone</td></tr>
<tr><td rowspan="6">Module</td><td colspan="6">$\phi V_{1,n,z}$ [kip/Module]</td></tr>
<tr><td rowspan="2">for:</td><td>$0 \leq P_{i,u,bolt} \leq 3.0$</td><td>$\pm(6.7 - |V_{i,u,y}|)$</td><td rowspan="2">for:</td><td>$0 \leq P_{i,u,bolt} \leq 13.2$</td><td>$\pm(8.1 - |V_{i,u,y}|)$</td></tr>
<tr><td>$3.0 \leq P_{i,u,bolt} \leq 13.1$</td><td>$\pm(\tfrac{2}{3}*(13.1 - P_{i,u,bolt}) - |V_{1,u,y}|)$</td><td>$13.2 \leq P_{i,u,bolt} \leq 25.3$</td><td>$\pm(\tfrac{2}{3}*(25.3 - P_{i,u,bolt}) - |V_{1,u,y}|)$</td></tr>
<tr><td colspan="6">$\phi V_{1,n,y}$ [kip/Module]</td></tr>
<tr><td rowspan="2">for:</td><td>$0 \leq P_{i,u,bolt} \leq 3.0$</td><td>$\pm\min\{5.2; \{6.7 - |V_{i,u,z}|\}$</td><td rowspan="2">for:</td><td>$0 \leq P_{i,u,bolt} \leq 13.2$</td><td>$\pm\min\{5.6; \{8.1 - |V_{i,u,z}|\}$</td></tr>
<tr><td>$3.0 \leq P_{i,u,bolt} \leq 13.1$</td><td>$\pm\min\{5.2; (\tfrac{2}{3}*(13.1 - P_{i,u,bolt}) - |V_{i,u,z}|\}$</td><td>$13.2 \leq P_{i,u,bolt} \leq 25.3$</td><td>$\pm\min\{5.6; (\tfrac{2}{3}*(25.3 - P_{i,u,bolt}) - |V_{i,u,z}|\}$</td></tr>
</table>

Table 5. Case 2 Shear Capacity

Notes:
Determination of axial forces $P_{i,u,bolt}$ acting on each bolt:
$P_{i,u,bolt} = P_{u,x}/4 \pm |M_{u,y}|/(4*z) \pm |M_{u,z}|/(4*y)$

Determination of shear forces resisted per module is dependent on axial loading of the bolts. For loading in:

- Compression: Both bolts in compression
- Compression and tension combined: One bolt in compression the other in tension
- Tension: Both bolts in tension

In each loaded area (compression, compression/tension, and tension) the maximum positive axial force $P_{i,u,bolt}$ must be used.

$\phi V_{i,n,z}$: Shear resistance in the z-direction for a single module, i, depends on the axial force, + $P_{i,u,bolt,}$ in that module, i.

$\phi V_{i,n,y}$: Shear resistance in the y-direction for a single module, i, depends on the axial force, + $P_{i,u,bolt,}$ in that module, i.

Conditions:

- The ratio of the vertical shear force $V_{u,z}$ and horizontal shear force $V_{u,y}$ for a single module is constant.
- $V_{u,z} / V_{u,x} = \phi V_{i,n,z} / \phi V_{i,n,y} = \phi V_{n,z} / \phi V_{n,y}$
- If the condition is not met, a reduction must be made to $V_{u,z}$ or $V_{u,x}$ in order to keep the ratio constant in the module.
- $V_{u,z} \leq \sum \phi V_{i,n\,z}$
- $V_{u,y} \leq \sum \phi V_{i,n\,y}$

Case 3. Cantilevered Steel Connection with Vertical Shear ±V_z, Horizontal Shear ±V_y and Axial Forces ±P_x, and Moments in the vertical and horizontal planes ±M_y and ±M_z with multiple connecting modules.

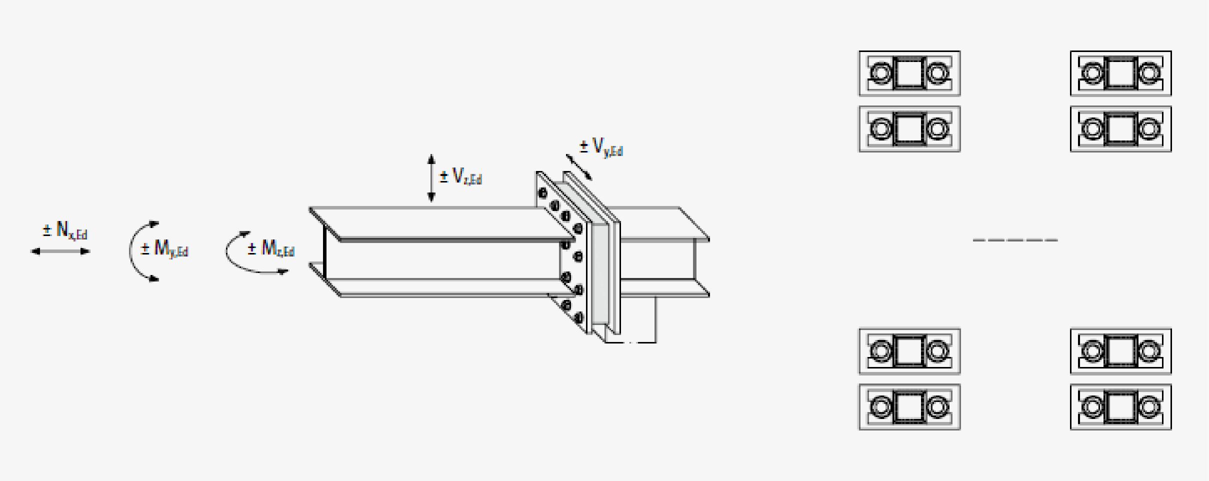

Figure 9. Case 3: Complex Cantilevered Steel Connection

Axial resistance per bolt

Schöck Isokorb® Module	S16	S22
Axial Capacity per:	$\phi P_{n,\,bolt}$ [kip/Bolt]	
Bolt	±13.1	±25.3
	$\phi P_{n,\,bolt,\,Mz}$ [kip/Bolt]	
Bolt	±6.6	±12.7

Table 6. Case 3 Axial Capacity

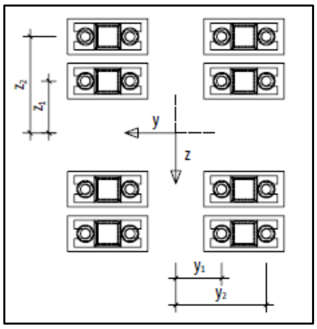

Figure 10. Case 3: Module Lever Arms

Axial forces in the bolts can be combined with the lever arm to resist moment forces in the connection. +$\phi P_{n,\,bolt}$ is considered a bolt in tension and -$\phi P_{n,\,bolt}$ is considered a bolt in compression.

Numbering the multiple bolts:

- m:	Number of bolts per connection in the z-direction
- n:	Number of bolts per connection in the y-direction

Force Components:

- Axial force $P_{u,x}$	$P_{1,u,bolt} = P_{u,x} / (m*n)$
- Moment about y-axis $M_{u,y}$	$P_{2,u,bolt} = \pm M_{u,y} / (2*m*z_2 + 2*m*z_1/z_2*z_1)$
- Moment about z-axis $M_{u,z}$	$P_{3,u,bolt} = \pm M_{u,y} / (2*n*y_2 + 2*n*y_1/y_2*y_1)$

-

Check required of conditions of bi-axial moment and axial force combinations:

- Condition 1: Bi-axial moment check combined with axial force:

$$|P_{1,u,bolt} + P_{2,u,bolt} + P_{3,u,bolt}| \leq |\phi P_{n,bolt}| \text{ [kip/Bolt]}$$

The maximum or minimum loaded bolt is the governing case

- Condition 2: Axial force combined with minor (z-axis) moment:

$$|P_{1,u,bolt} + P_{3,u,bolt}| \leq |\phi P_{n,bolt,\,Mz}| \text{ [kip/Bolt]}$$

Case 3. Continued

Shear resistance per module and per connection

Schöck Isokorb® Module	**S16**			**S22**		
Capacity per:	Shear Resistance for Compression Zone					
Module	$\phi V_{i,n,z}$ [kip/Module]					
	$\pm(10.3 - \lvert V_{i,u,y}\rvert)$			$\pm(11.2 - \lvert V_{i,u,y}\rvert)$		
	$\phi V_{i,n,y}$ [kip/Module]					
	$\pm\min \{5.2; (10.3 - \lvert V_{i,u,z}\rvert)\}$			$\pm\min \{5.6; (11.2 - \lvert V_{i,u,z}\rvert)\}$		
	Shear Resistance for Tension/Compression Zone and Tension Zone					
Module	$\phi V_{i,n,z}$ [kip/Module]					
	for:	$0 \leq P_{i,u,bolt} \leq 3.0$	$\pm(6.7 - \lvert V_{i,u,y}\rvert)$	for:	$0 \leq P_{i,u,bolt} \leq 13.2$	$\pm(8.1 - \lvert V_{i,u,y}\rvert)$
		$3.0 \leq P_{i,u,bolt} \leq 13.1$	$\pm(\frac{2}{3}*(13.1 - P_{i,u,bolt}) - \lvert V_{i,u,y}\rvert)$		$13.2 \leq P_{i,u,bolt} \leq 25.3$	$\pm(\frac{2}{3}*(25.3- P_{i,u,bolt}) - \lvert V_{i,u,y}\rvert)$
	$\phi V_{i,n,y}$ [kip/Module]					
	for:	$0 \leq P_{i,u,bolt} \leq 3.0$	$\pm\min \{5.2; \{6.7 - \lvert V_{i,u,z}\rvert\}$	for:	$0 \leq P_{i,u,bolt} \leq 13.2$	$\pm\min \{5.6; \{8.1 - \lvert V_{i,u,z}\rvert\}$
		$3.0 \leq P_{i,u,bolt} \leq 13.1$	$\pm\min\{5.2; (\frac{2}{3}*(13.1- P_{i,u,bolt}) - \lvert V_{i,u,z}\rvert\}$		$13.2 \leq P_{i,u,bolt} \leq 25.3$	$\pm\min\{5.6; (\frac{2}{3}*(25.3 - P_{i,u,bolt}) - \lvert V_{i,u,z}\rvert\}$

Table 7. Case 3 Shear Capacity

Notes:

Determination of axial forces $P_{i,u,bolt}$ acting on each bolt:

$$P_{i,u,bolt} = P_{u,x}/(m*n) \pm |M_{u,y}|/(2*m*z_2 + 2*m*z_i/z_2 * z_i) \pm |M_{u,z}|/(2*n*y_2 + 2*n*y_i/y_2 * y_i)$$

Determination of shear forces resisted per module is dependent on axial loading of the bolts.
For loading in:

- Compression: Both bolts in compression
- Compression and tension combined: One bolt in compression the other in tension
- Tension: Both bolts in tension

In each loaded area (compression, compression/tension, and tension) the maximum positive axial force $P_{i,u,bolt}$ must be used.

$\phi V_{i,n,z}$: Shear resistance in the z-direction for a single module, i, depends on the axial force, + $P_{i,u,bolt}$, in that module, i.

$\phi V_{i,n,y}$: Shear resistance in the y-direction for a single module, i, depends on the axial force, + $P_{i,u,bolt}$, in that module, i.

Conditions:

- The ratio of the vertical shear force $V_{u,z}$ and horizontal shear force $V_{u,y}$ for a single module is constant.
- $V_{u,z} / V_{u,x} = \phi V_{i,n,z} / \phi V_{i,n,y} = \phi V_{n,z} / \phi V_{n,y}$
- If the condition is not met, a reduction must be made to $V_{u,z}$ or $V_{u,x}$ in order to keep the ratio constant in the module.
- $V_{u,z} \leq \sum \phi V_{i,n\,z}$
- $V_{u,y} \leq \sum \phi V_{i,n\,y}$

Deflections

Deflection of Schöck Isokorb® connection due to axial forces, $A_{u,x}$

Tension zone: $\Delta l_T = |+ P_{u,x}| * 1/k_T$
Compression zone: $\Delta l_C = |- P_{u,x}| * 1/k_C$
Stiffness constant in tension: k_T
Stiffness constant in compression: k_C

Schöck Isokorb® Module		**S16**	**S22**
Stiffness constant		K [kip/in]	
For:	Area		
Module	Tension	3379	4966
Module	Compression	14275	19690

Table 8. Stiffness Constants

Deflection of Schöck Isokorb® connection due to moment forces, $M_{u,y}$

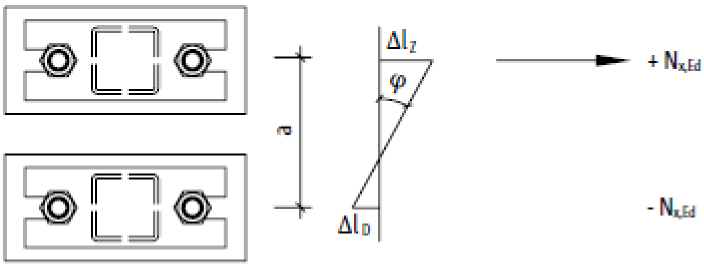

Figure 11. Deflection Calculation

$\varphi \approx \tan \varphi = (\Delta l_T + \Delta l_C) / a$
$\varphi \text{ [rad]} = M_y / C \text{ [rad]}$

φ [rad]: angle of deflection
M_y [kip*ft]: moment on the connection for the ULS deflection calculation
C [kip*in/rad]: rotational stiffness
A [in]: moment arm

Schöck Isokorb® Module	**2 x S16**	**2 x S22**
Rotational stiffness	C [kip*in/rad]	
Connection	$416 *a^2$	$611 *a^2$

Table 9. Rotational Stiffness

Schöck Isokorb® S-Line

Expansion joints/fatigue resistance

Horizontally movable connections

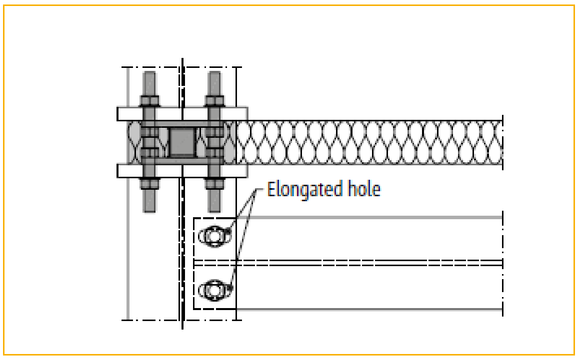

Figure 12. Slotted Connection for Thermal Movement

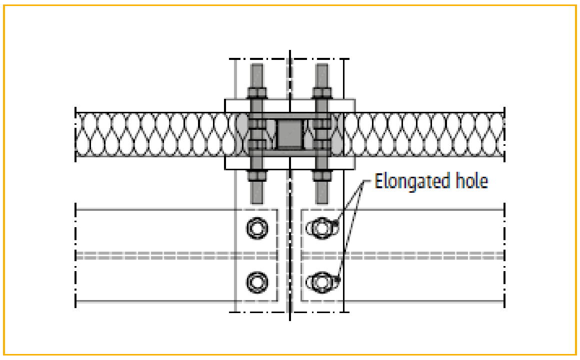

Figure 13. Expansion Joint by Slotted Connection

Effective deformation length l_{eff}

When using a thermal break for steel connections a steep temperature gradient is imposed at the building envelope between the interior and exterior steel structure. The interior structure under climate control is kept relatively stable and does not expand or contract significantly, while the exterior structure may undergo large temperature fluctuations. These temperature fluctuations can cause significant stress in the thermally broken connection and, if the stress is too large, can limit the fatigue life of the connection. To prevent this, a maximum length between connections before an expansion joint or other relief method is introduced (l_{eff}).

This permitted effective deformation length is the maximum distance apart that two or more Schöck Isokorb® type S connections may be arranged if the structure connected to the Schöck Isokorb® type S cannot freely expand in length, thus leading to horizontal shifts in the Schöck Isokorb® type S.

Expansion joint length l_{ex}

This length covers the expansion joint spacing and can also be bigger than the effective deformation length

$l_{eff} \leq l_{ex}$

The permitted effective deformation length depends on:

- the design of the on-site end plate (high tolerances)
- the temperature differences
- the stiffness of the exterior steel structure

The definition and verification of these boundary condition lies with the Engineer of Record (EOR). Please feel free to contact our North American Design Department for further information.

Schöck Isokorb® S-Line

Expansion joints/fatigue resistance

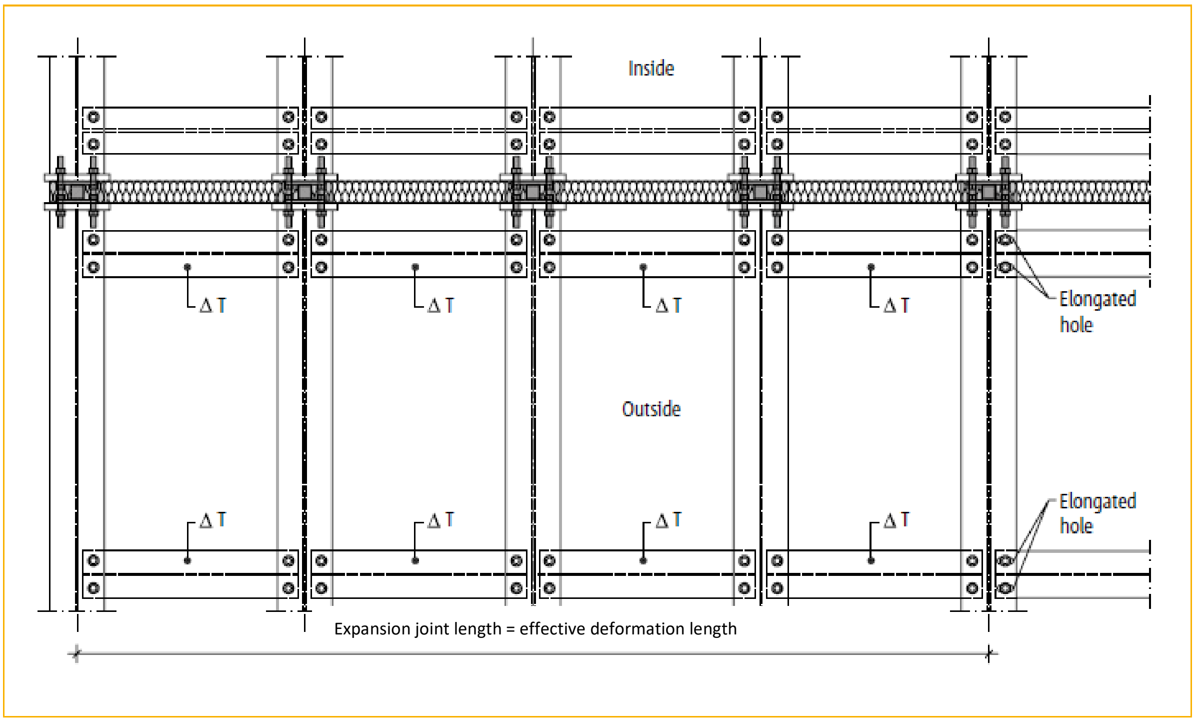

Figure 14. Expansion Joint Spacing (zero movement at central fixed point)

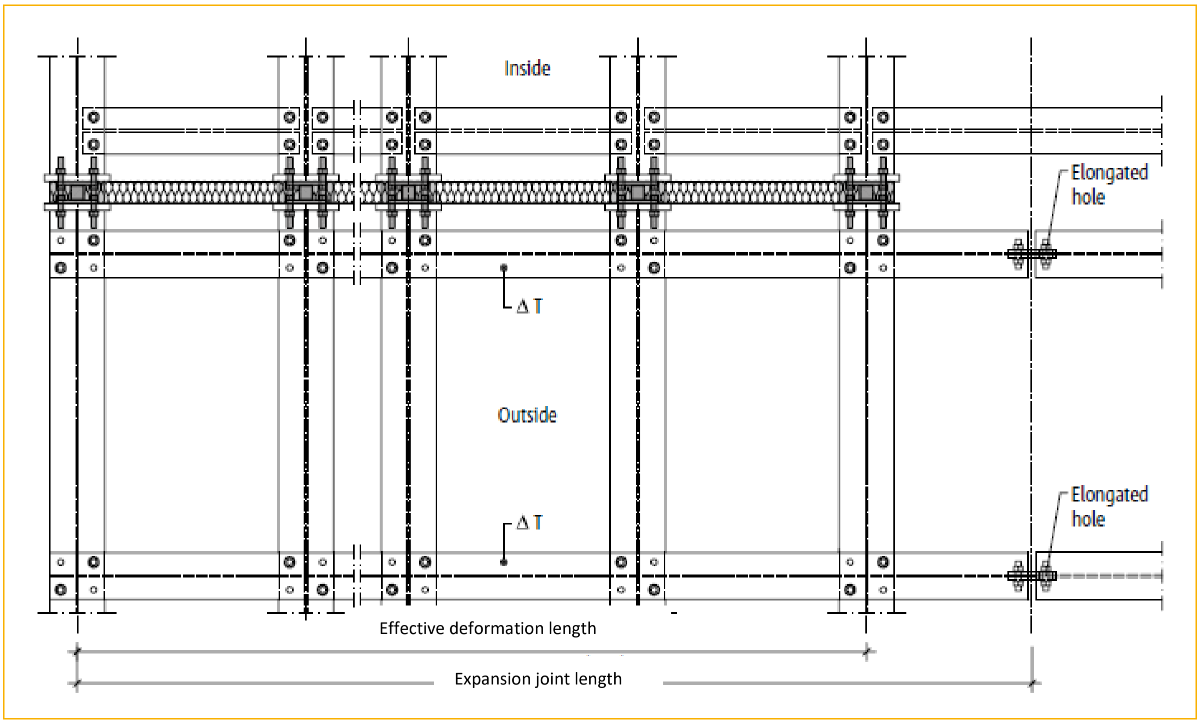

Figure 15. Expansion Joint Spacing Higher than Spacing of Effective Deformation Length