Steel for bricks

Geoconnect®

Structures

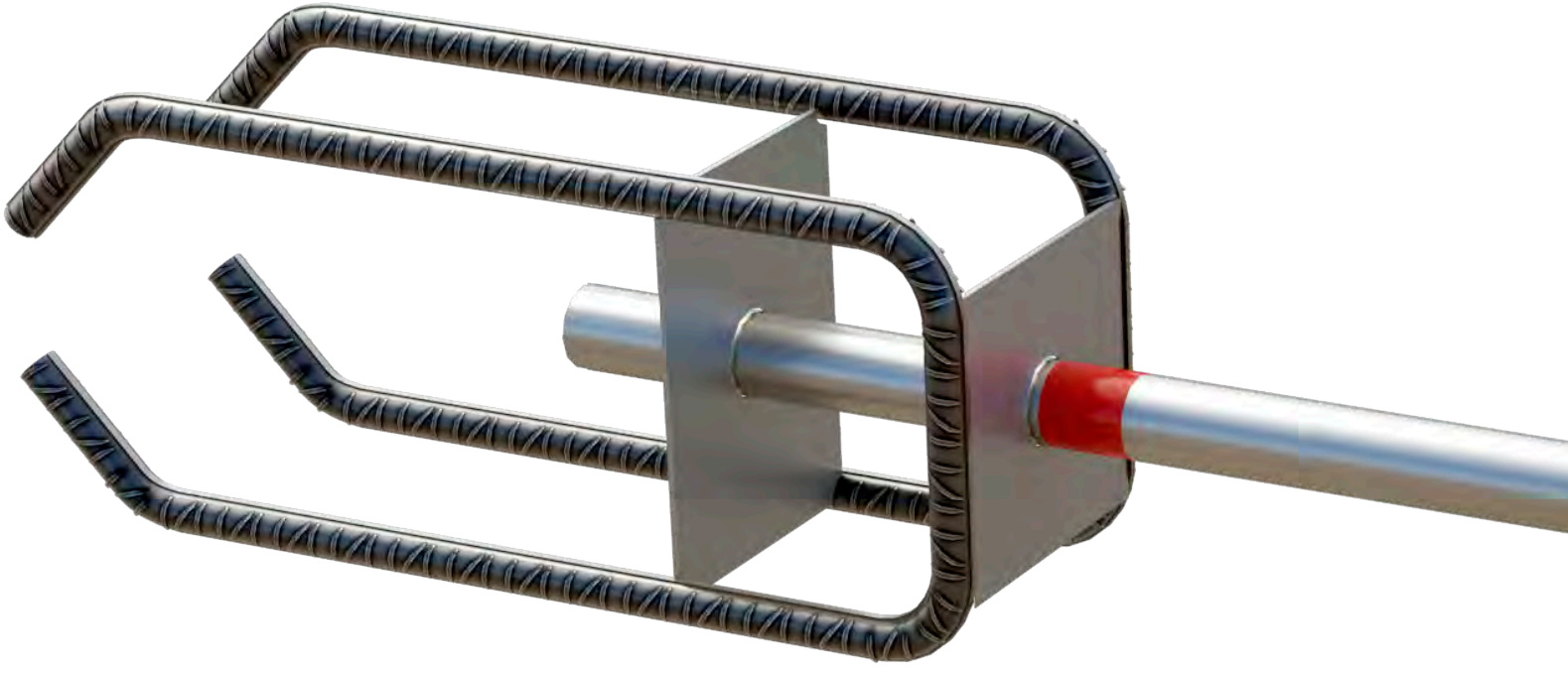
Geoconnect®
Slab-Slab Connection

DAU 15/096 ITeC

CE

grupo GZ

Index



User Information

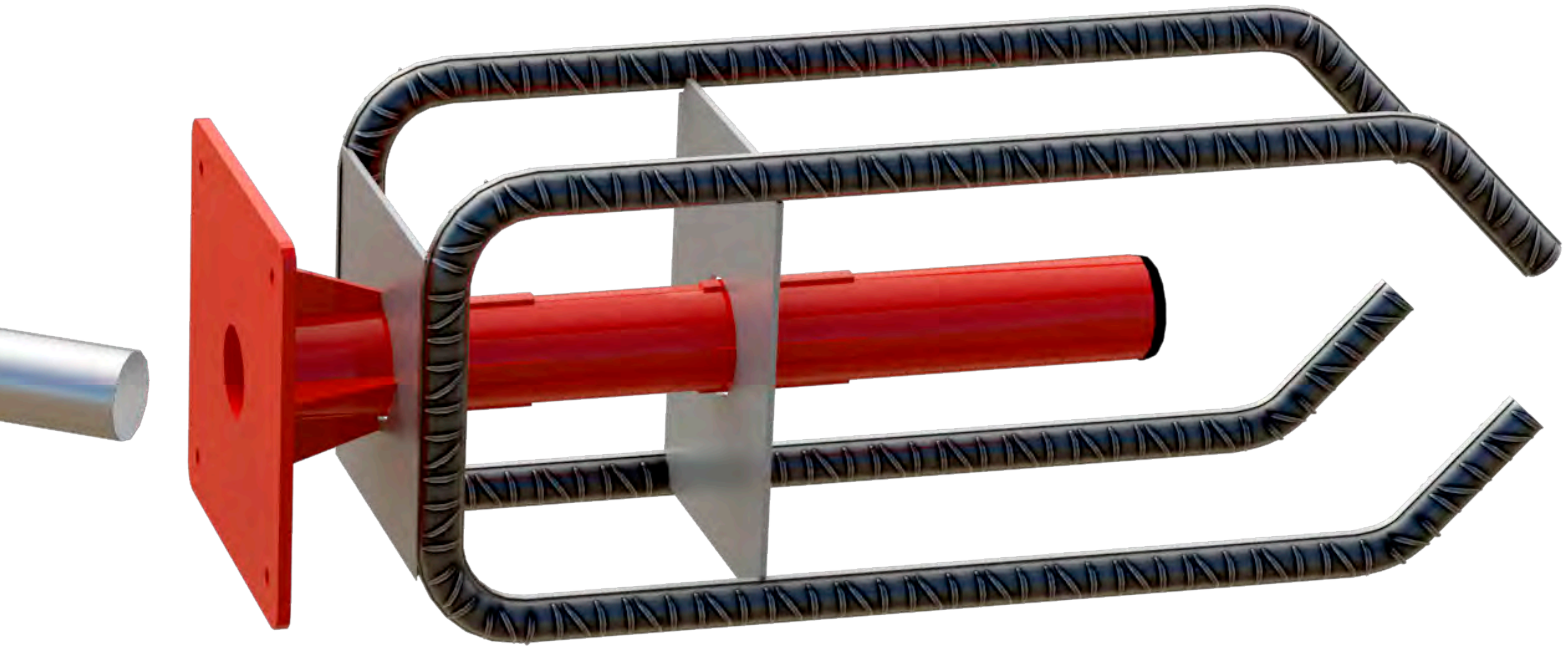
Reinforced concrete structures have expansion joints designed in accordance with building expansion and contraction requirements. These joints allow the reinforced slabs to move and prevent cracks appearing, thus eliminating any ensuing problems.

One suitable, technically proven solution to ensure the correct transfer of shear across this type of joint is the structural connector. These connectors enable design flexibility, simple and safe installation, whilst offering viable economical solutions (compared to other conventional methods).

July 2013 saw the first specific European Directive on structural connectors for expansion joints. Previously, manufacturers used specific testing or national certificates that had no legal validity across Europe, nor did the specifiers have sufficient backing to ensure project viability.

With the approval in April 2013 of ETAG 030 Connectors for Structural Joints (Guideline for European Technical Approval of Dowels for Structural Joints), SFB focused its effort on achieving the first accreditation in Europe and to comply with all the requirements of this sector by means of an optimum system.

The *Geoconnect® LL* Shear Load Connectors are the first structural connectors to be granted the CE marking in Europe.



ITeC (Institute of Construction) compiled ETA 16/0064, the reference document that has made this European certification a reality. Furthermore, ITeC issued DAU 15/096 for the *Geoconnect® LL* Shear Load Connectors.

With these certificates, SFB can offer the market solutions to connect structural elements with features that are proven at European level, accompanying the project criteria and implementation required to ensure the product works properly on site.

This technical approval provides legal backing for the Specifier, Technical Manager, Construction Company and Developer.

Structural connectors should not be judged by their aesthetics, but rather by their load capabilities, the simplicity of use and the overall cost benefits to the construction program.

1. Solutions for Structural Expansion Joints

Expansion joints for building and civil works are designed to accommodate the contractions and expansions arising from seismic effects, temperature changes and concrete shrinkage, enabling the structural elements to move without causing cracks or fissures.

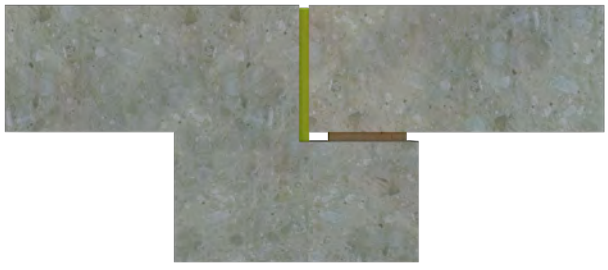
The Structural Concrete Regulation (EHE) requires an expansion joint to be included on long concrete elevations at specified centres to avoid complications arising from thermal movement.

The traditional solutions for treating expansion joints between slabs are double columns, keyed joints and corbel supports.

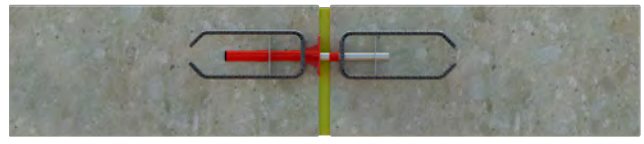
These conventional solutions may have an impact on the design and aesthetics of a building, such as the use of space or complicated formwork, in addition to the economic considerations when compared to using structural connectors.

For example, freeing up a dual support enables a saving in the line of columns and increases the useful space for the construction of car parks (the usable scope of parking places is increased for vehicles that are progressively larger), shopping centres, apartments and office buildings.

Equally, the corbel support and made-to-measure slab implementation costs are reduced, as are the costs of building the columns and maintaining their vertical joints.

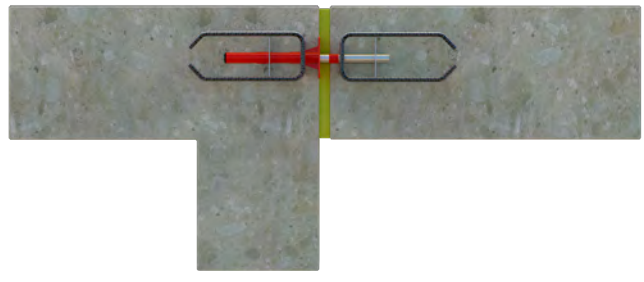


• Conventional corbel support solution



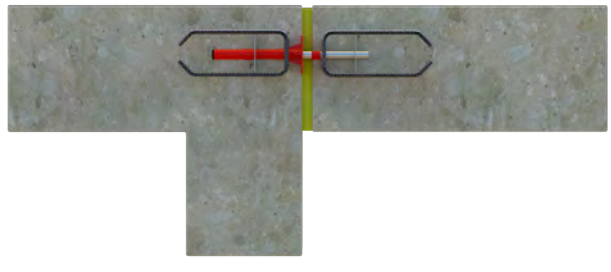
• *Geoconnect®LL* solution: Linear joint

• Conventional solution with corbel support



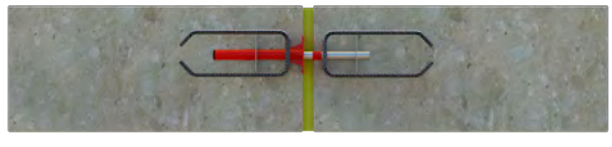
• *Geoconnect®LL* solution: Corbel support eliminated

• Conventional solution with double columns



• *Geoconnect®LL* solution: Double column eliminated

• Conventional keyed joint solution



• *Geoconnect®LL* solution: Linear joint

2. Description of Geoconnect® Shear Load Connectors

The *Geoconnect®* Shear Load Connector comprises two traditional elements - dowel and sleeve - in addition to local reinforcement (*Geoconnect® Reinforcement*).

The connector is available in six different diameters, which enables precision of choice based on the load study and the geometry of the structural elements.

2.1. Dowel

This consists of a solid steel rod, the length of which varies depending on the diameter. It comes assembled with local *Geoconnect® Reinforcement* (specific to the dowel diameter).

The coloured mark on the dowel identifies the diameter of the shear load connector, also defining the point at which the dowel penetrates the sleeve and the correct concrete cover for the frame.

2.2. Sleeve

A component with a circular or rectangular cross-section (depending on connector type), its length depending on the dowel diameter. It has a drilled plate which can be mechanically attached to the formwork.

It comes assembled with local *Geoconnect® Reinforcement*.

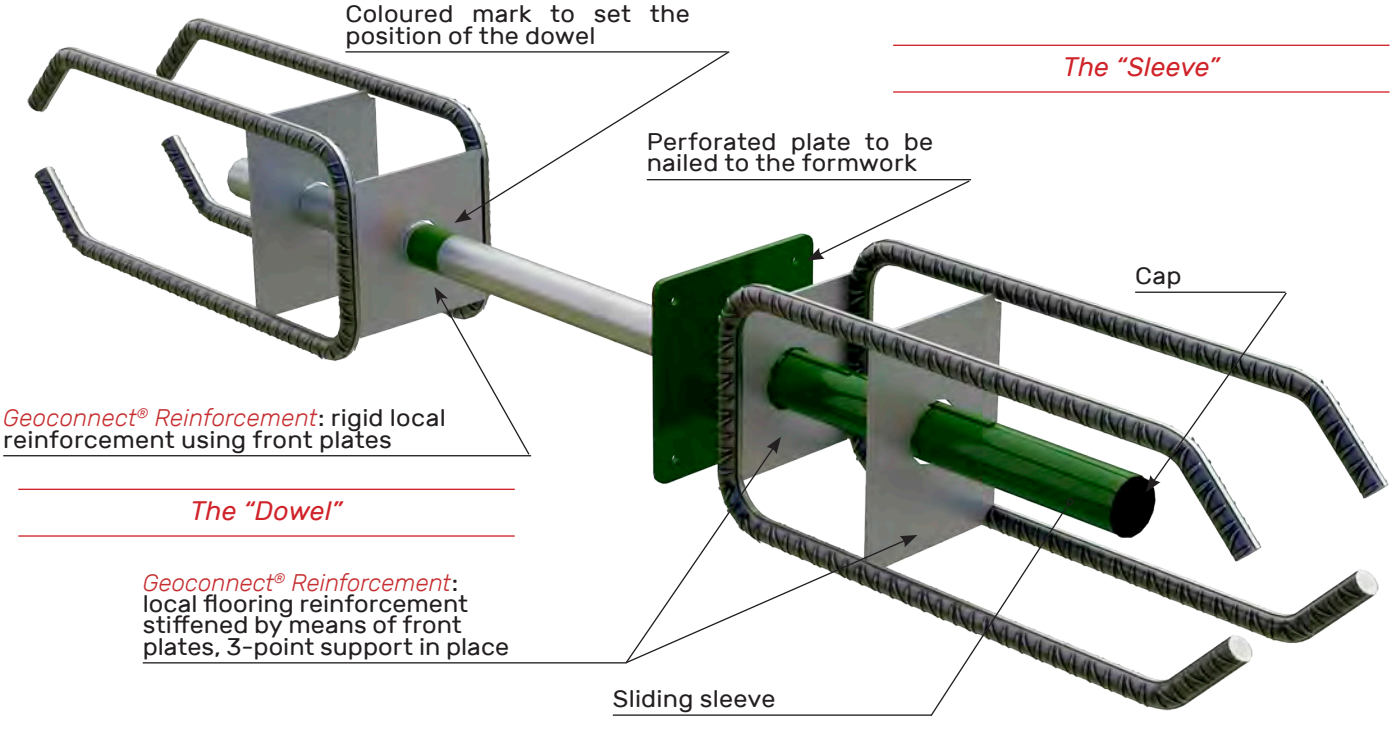
To avoid any confusion, the plastic sleeves are produced in colours that match that of the colour mark on the dowels. Both the stainless steel and plastic versions also come with the colour code on their labels.

2.3. Local Reinforcement: Geoconnect® Reinforcement

This element consists of reinforcing frames and two front plates (where the dowels and sleeves are mounted).

The frames are produced in corrugated steel, as per EN 10080 (type B 500 S), and 1.5 mm thick separation plates in S235 carbon steel, as per EN 10025-2.

The welded *Geoconnect® Reinforcement* unit is designed to ensure concrete cover, correct alignment of the dowel and sleeve, and to allow vibration of the concrete.



3. Range of Geoconnect® Slab-Slab Products

3.1. Based on Type of Joint Movement

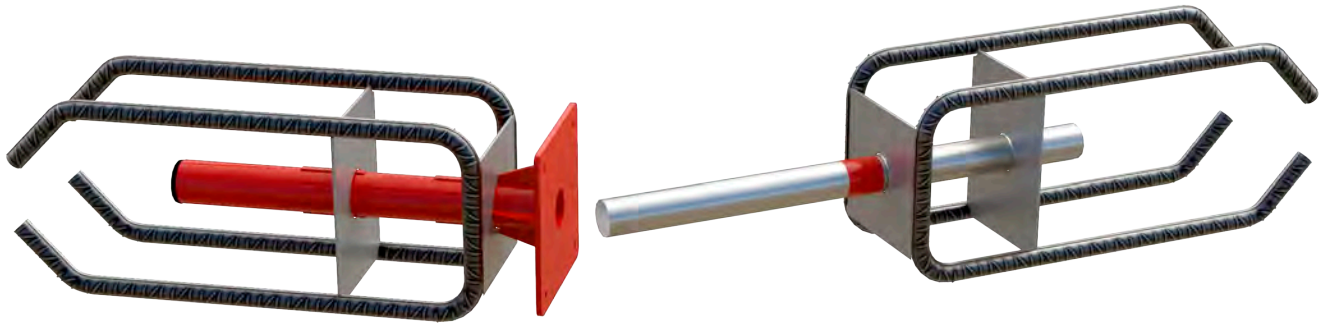
Geoconnect® LL Shear Load Connectors are an engineered product that enables shear stress to be transferred across expansion joints between slabs, flagstones, beams and walls, allowing for structural movement.

The *Geoconnect®* Shear Load Connector range includes two product types, in accordance with the type of joint movement required.

3.1.1. The Geoconnect® Standard Slab-Slab Connection for Joints with Single Movements

A shear load connector with a certain freedom of movement for the dowel in the axial direction along the sleeve, but no movement enabled in any other direction.

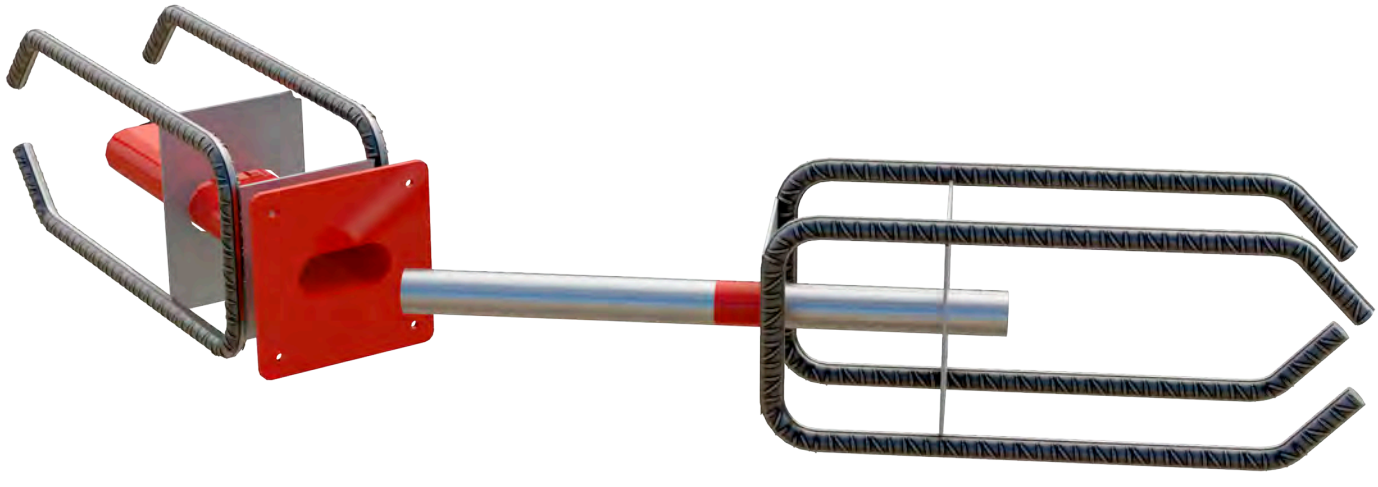
It comes with 3 basic elements: a steel dowel (circular cross-section), a sliding sleeve (circular cross-section) and local reinforcement. It can be used for joints of up to 60mm wide.



3.1.2. The Geoconnect® DM Slab-Slab Connection for Joints with Dual Movements

A shear load connector with two types of freedom of movement for the dowel in the axial direction along the sleeve, and transversal to the axis of the connector.

It is suitable for situations which also require freedom of movement parallel to the joint in geometrical configurations with floor breaks, i.e. having joints in the shape of a “Z”, “U” or “cross”.



Once again there are three elements: dowel, sleeve and local reinforcement. However, here the sleeve has a rectangular cross-section allowing for the dowel to slide both lengthwise and transversally.

The “*DM centering*” system for the dowel inside the sleeve aids in the installation, and ensures it is in the correct initial position in the transversal axis. It can be used for joints of up to 60mm wide.

3.2. Based on Type of Material

Aside from having the required mechanical properties, the shear load connector needs to be highly corrosion-resistant as it will be placed in expansion joints which are subject to potentially aggressive environmental conditions, as maintenance work is impossible once installed.

The *Geoconnect®* Shear Load Connector dowels are produced in different qualities of steel: galvanized steel (*Geoconnect® G Series*) and stainless steel (*Geoconnect® I Series*).

Geoconnect® G is made from EN 1.7225 steel (42 CrMo4). The anti-corrosion layer comes from being submerged in a zinc bath. This layer works in two ways: barrier protection and cathodic protection.

Geoconnect® I is made from highly resistant stainless steel - EN 1.4462 (X2CrNiMoN22-5-3) - for excellent corrosion resistance.

There are two types of sleeve: polypropylene or metal sleeve. The plastic sleeve is recommended for both *Geoconnect® G* and *Geoconnect® I* dowels. The metal sleeve is produced in EN 1.4301 stainless steel (X5CrNi18-10).

Stainless steel sleeves cannot be used with galvanized sleeves, otherwise problems could occur through bi-metallic corrosion.

3.3. Based on the Elements to be Connected

Under special circumstances the composition of a connector system may be modified:

- *LL Series:* Connection between screed and slabs which enables all the parts of the *Geoconnect®* Shear Load Connector to be installed: dowel, sleeve and local reinforcement (*Geoconnect® Reinforcement*).
- *W Series:* Low thickness screed and slabs, where reinforcement cannot be used. This series includes just the dowel and reinforcement, but no local reinforcement (*Geoconnect® Reinforcement*).
- *WH Series: Geoconnect®* Shear load connectors joining a structural element to an already present element. This series features a dowel (without any reinforcement) placed in a bored hole in a pre-existing element, and a sleeve with local reinforcement (*Geoconnect® Reinforcement*) in the element to be attached.
- *WM Series:* In low thickness walls where *Geoconnect® Reinforcement* cannot be used. This series is designed to house the sleeve in a narrow wall prior to attaching the dowel and its reinforcement - without the need to drill holes - to achieve the movement required.

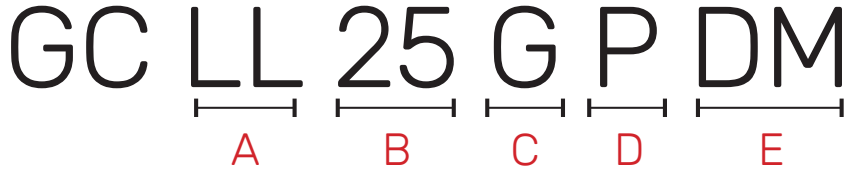
Based on the combination of dowels, sleeves and *Geoconnect® Reinforcement,* this series of products can be summarised as follows:

	Sleeve	Geoconnect ® Reinforcement Sleeve	Dowel	Geoconnect ® Reinforcement Dowel
GC - LL	X	X	X	X
GC - W	X		X	
GC - WH	X	X	X	
GC - WM	X		X	X

NB: The series of special Shear Load Connectors (W, WH and WM) have limited provisions compared to those of the LL series as they lack one or more of the components of that connector.

3.4. Component Identification

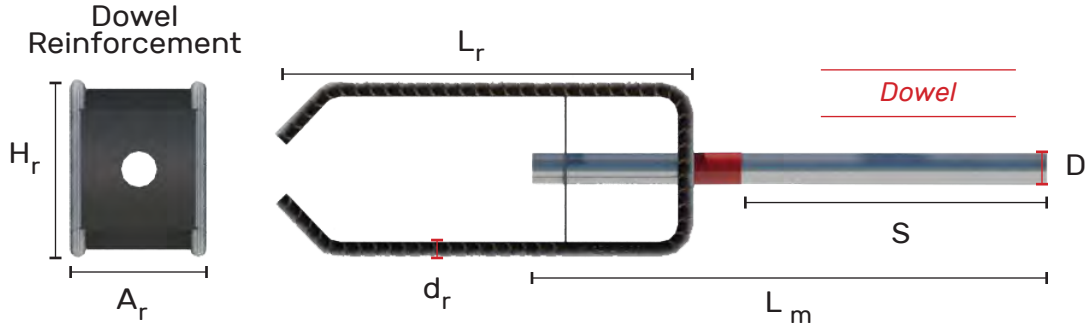
- A: Connection type: LL/W/WH/WM
- B: Dowel diameter in mm
- C: Dowel material: G (galvanized steel); LI (stainless steel)
- D: Sleeve material: LI (stainless steel); P (plastic)
- E: Joint movement type: DM (dual movement)



3.5. Component Dimensions

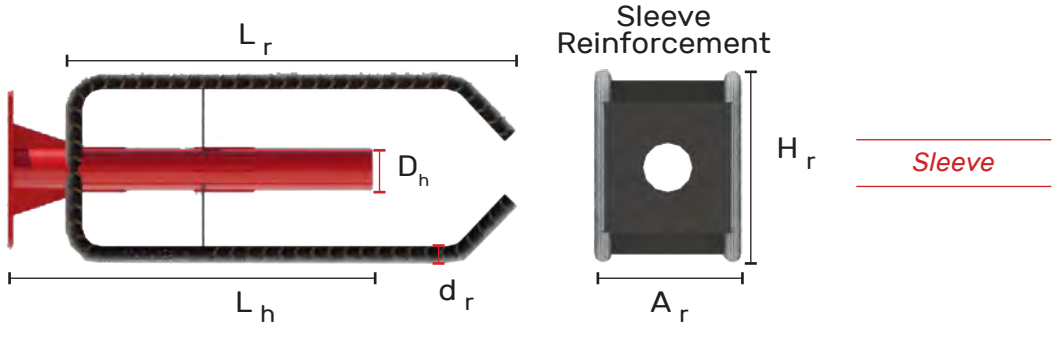
The following tables show the standard values for dowel diameters, sleeve size and reinforcements.

3.5.1. Dimensions of the dowel and local Geoconnect® Reinforcement (mm)



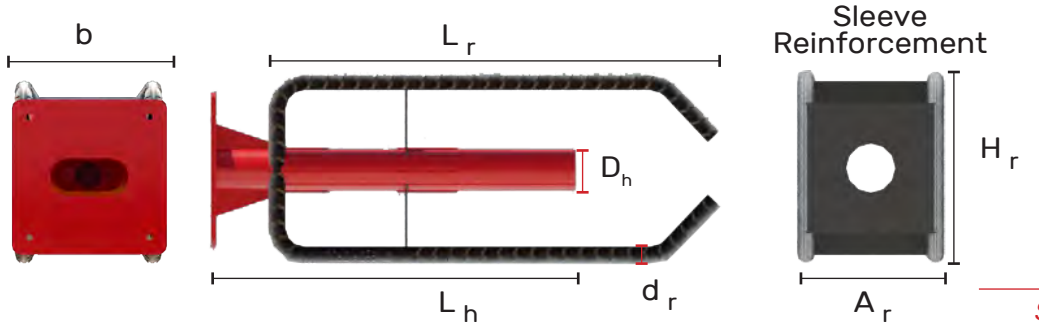
Reference	Dowel			Local Reinforcement (Geoconnect® Reinforcement)				Slab Depth
	Diameter	Length	Protrusion	Diameter	Length	Height	Width	
	D	L_m	S	d_r	L_r	H_r	A_r	
GC-20	20	320	190	10	260	110	85	≥ 180
GC-22	22	350	205	10	260	110	85	≥ 180
GC-25	25	390	225	12	300	125	100	≥ 200
GC-30	30	450	255	12	300	125	100	≥ 200
GC-35	35	520	290	16	350	140	120	≥ 250
GC-40	40	580	320	16	350	140	120	≥ 250

3.5.2. Dimensions of the sleeve for single movements and local Geoconnect® Reinforcement (mm)



Reference	Sleeve		Local Reinforcement (Geoconnect® Reinforcement)				Slab Depth
	Diameter	Length	Diameter	Length	Height	Width	
	D_h	L_h	d_r	L_r	H_r	A_r	
GC-20	21	210	10	260	110	85	≥ 180
GC-22	23	225	10	260	110	85	≥ 180
GC-25	26	245	12	300	125	100	≥ 200
GC-30	31	275	12	300	125	100	≥ 200
GC-35	36	310	16	350	140	120	≥ 250
GC-40	41	340	16	350	140	120	≥ 250

3.5.3. Dimensions of the sleeve for dual movements and local Geoconnect® Reinforcement (mm)

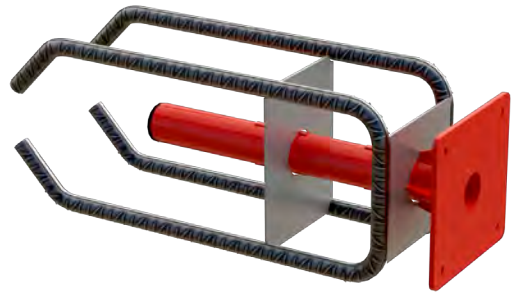


Sleeve

Reference	Dual Movement Sleeve			Local Reinforcement (Geoconnect®)				Slab Depth
	Diameter	Length	Width	Diameter	Length	Height	Width	
	D_h	L_h	b	d_r	L_r	H_r	A_r	
GC-20 DM	21	210	46	10	260	110	85	≥ 180
GC-22 DM	23	225	47	10	260	110	85	≥ 180
GC-25 DM	26	245	56	12	300	125	100	≥ 200
GC-30 DM	31	275	62	12	300	125	100	≥ 200
GC-35 DM	36	310	76	16	350	140	120	≥ 250
GC-40 DM	41	340	77	16	350	140	120	≥ 250

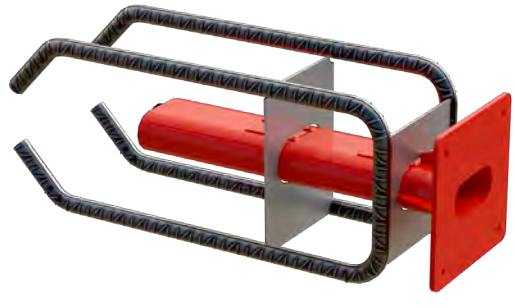
3.5.4. Dimensions of the front plate on the sleeve to nail the single movement sleeve in place (mm)

Reference	Stainless Steel Sleeve		Plastic Sleeve	
	Width	Height	Width	Height
GC-20	90	90	90	90
GC-22	90	90	90	90
GC-25	90	90	90	90
GC-30	90	90	90	90
GC-35	90	90	90	90
GC-40	90	90	90	90



3.5.5. Dimensions of the front plate on the sleeve to nail the dual movement sleeve in place (mm)

Reference	Stainless Steel Sleeve		Plastic Sleeve	
	Width	Height	Width	Height
GC-20 DM	90	90	90	90
GC-22 DM	90	90	90	90
GC-25 DM	90	90	90	90
GC-30 DM	90	90	90	90
GC-35 DM	90	90	90	90
GC-40 DM	120	100	90	90

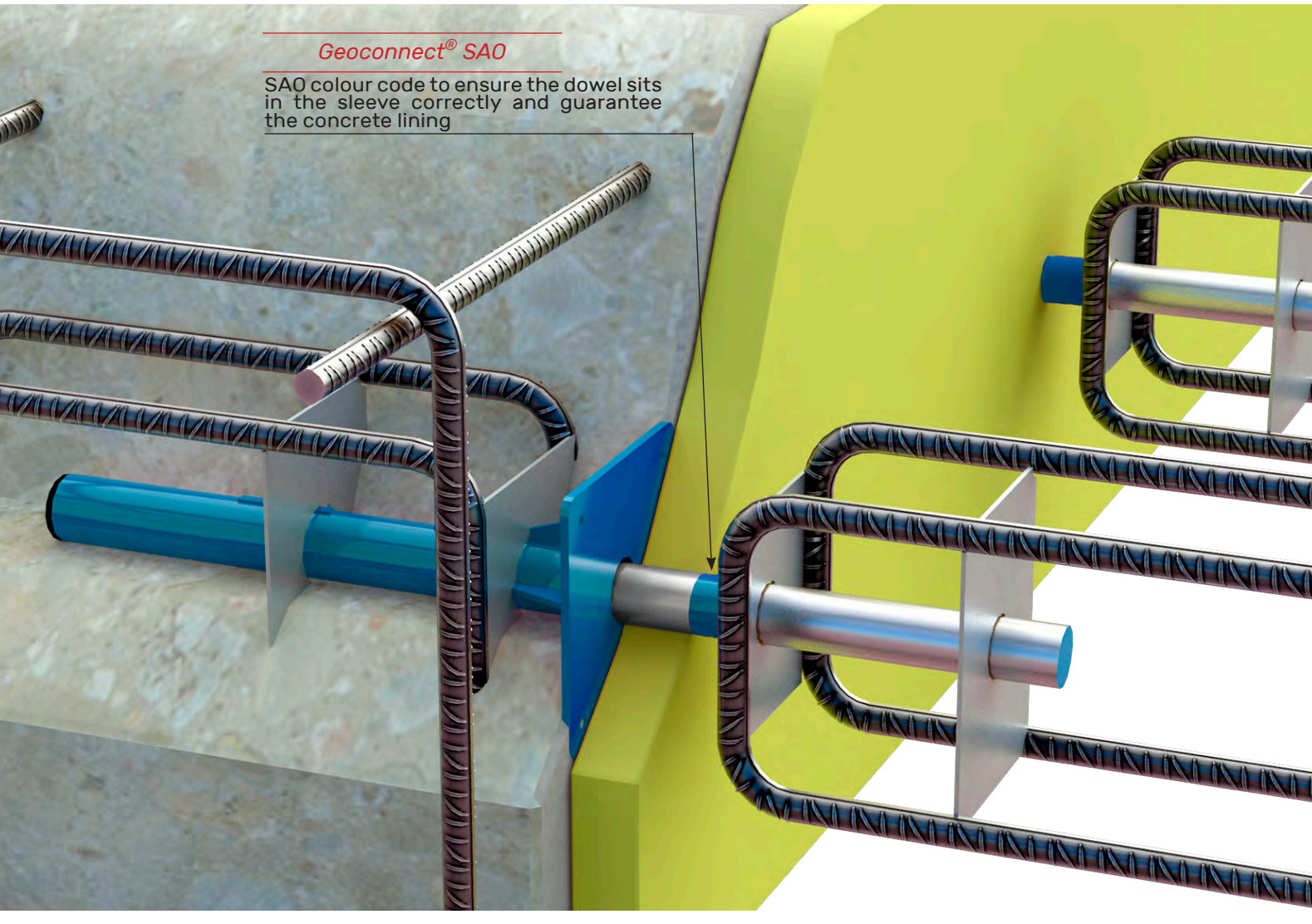


3.6. Colour Code: *Geoconnect®* SAO & *Geoconnect®* One to One

To avoid confusion during installation, the "*Geoconnect® One to One*" system has a colour code to identify all components.

This ensures an unambiguous link in the installation process between the codes for the dowel and for the sleeves. The SAO dowel diameter reference colour code must be the same as the sleeve colour used with the dowel.

Reference	Diameter	Colour
GC-20	20	Red
GC-22	22	Black
GC-25	25	Blue
GC-30	30	Purple
GC-35	35	Green
GC-40	40	Orange



4. Features of the Geoconnect® LL System

The features which should be present in any structural joint system with connectors are basically those of mechanical resistance to transfer loads from one side of the joint to the other and the possibility of allowing the connecting elements freedom of movement. These features are achieved through good design and sufficient dimensions for all the elements involved in the mechanical behaviour of the structural joint, not just for the elements provided by the connector system supplier, but also for the concrete and frames of the elements being joined.

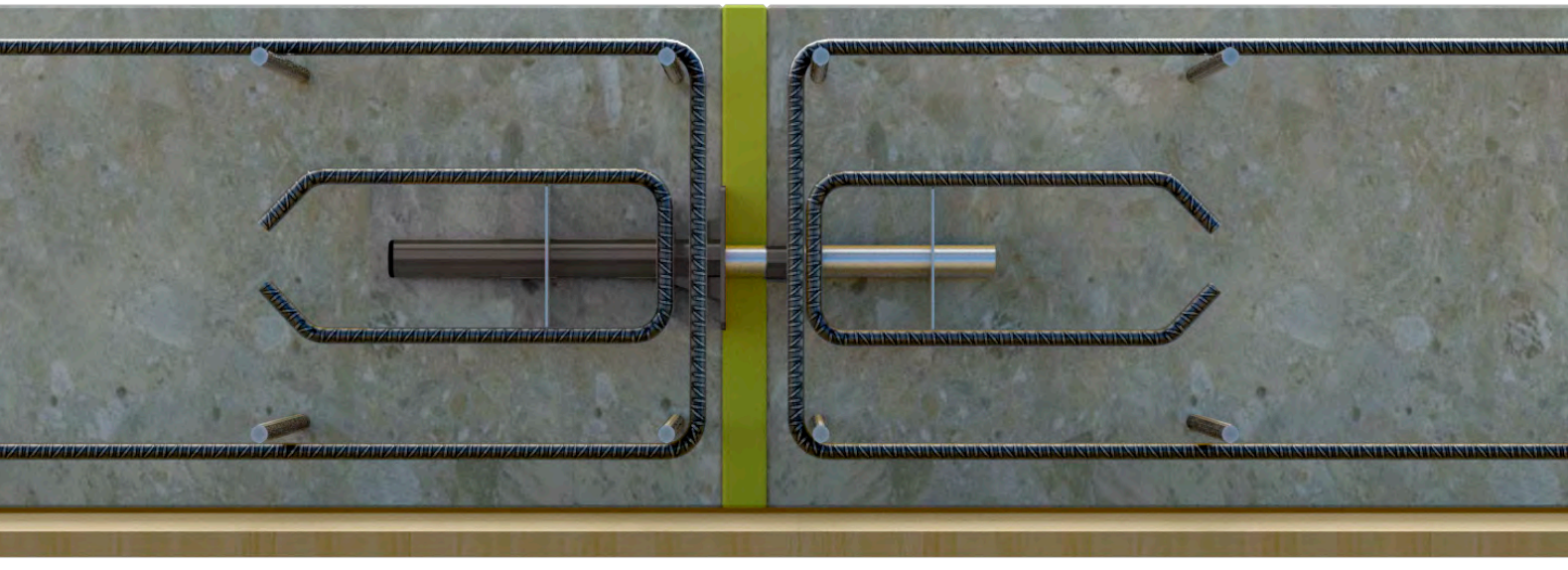
4.1. Mechanical Resistance of the System

The structural expansion joint solution must be considered as a system in which various elements are involved which condition the resistance of the connector.

The ability to transfer forces through the concrete is as important as the resistance of the dowel; thus key parameters include the type of concrete, depth of the slab, frame of the edge beam, suspension reinforcement and joint width.

Any structural connector system should consider the following elements:

- Type of concrete
- Slab depth
- Joint width
- Dowel
- Sleeve
- Local reinforcement included in the connector
- Suspension framework
- Edge beam frame



4.1.1. Type of Concrete

The resistance of the concrete is a leading parameter in the load capacity of a structural joint system, given it is the element through which forces are transferred between the connected slabs.

Concrete resistance directly affects the stated resistance values of the connectors, as it limits the capacity to resist the system shear arising from edge bending.

4.1.2. Slab Depth

The depth of the connected slabs directly affects the stated resistance values of the connectors, as it limits the capacity to resist the system shear arising from edge bending and possible punching shear.

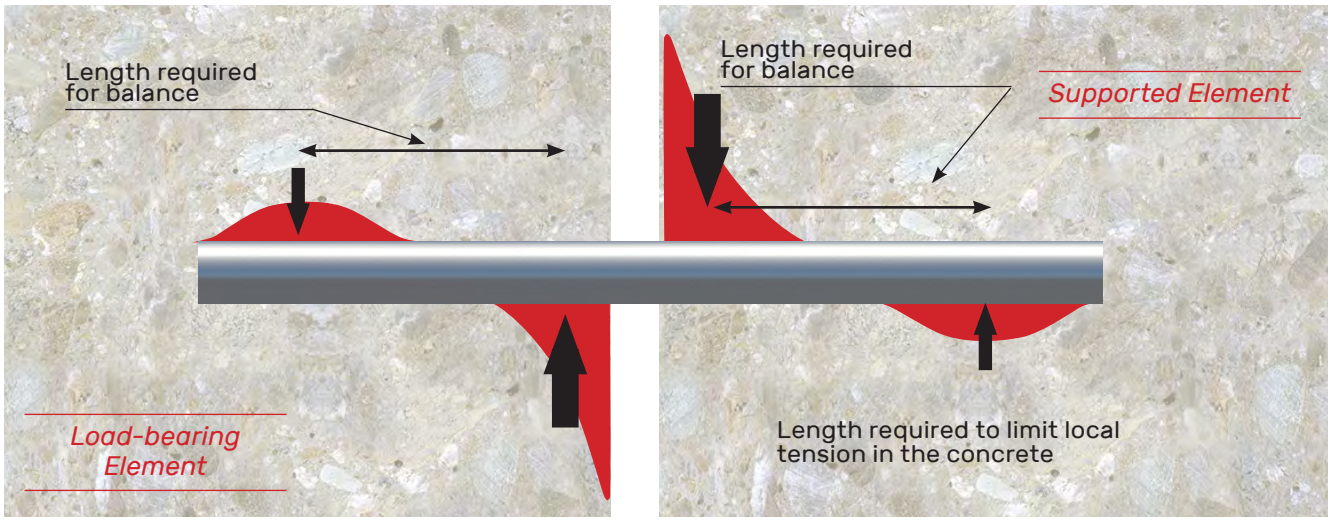
4.1.3. Joint Width

The maximum intended width for the opening of the expansion joint directly affects the stated resistance values of the connectors, as it limits the system's resistance capacity as a consequence of possible dowel failure resulting from bending.

4.1.4. Dowel

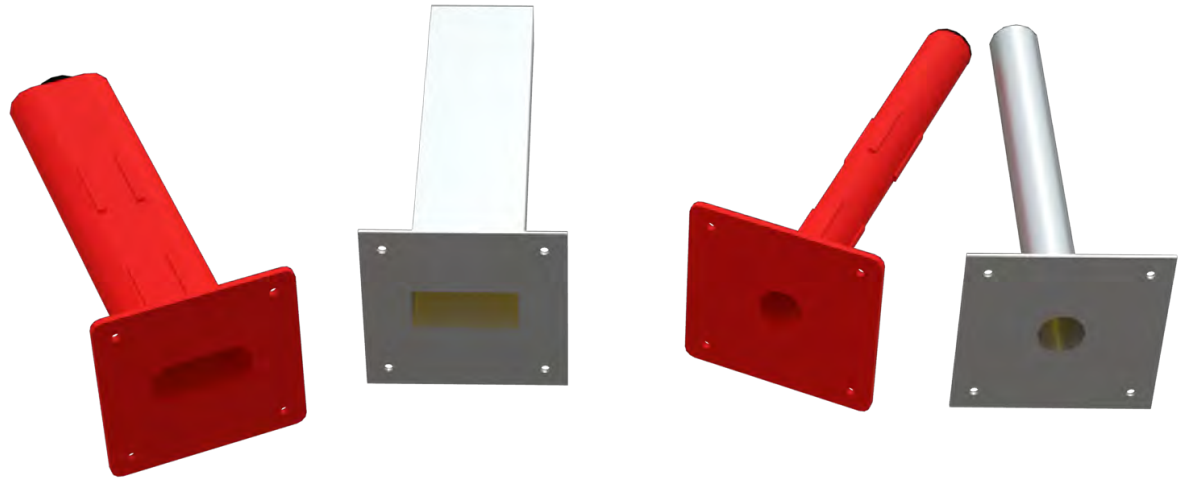
The dimensions of the dowel and the mechanical resistance of steel directly affect the stated resistance values of the connectors, as they condition the system's resistance capacity as a consequence of possible dowel failure resulting from bending and shear.

Model of the Mechanical Response of Concrete on the Dowel



4.1.5. Sleeve

The length of the sleeve directly affects the stated resistance values of the connectors, as it conditions the depth the dowel penetrates the concrete and, in turn, the proper distribution of forces to prevent possible failure due to localised crushing.



4.1.6. Local Reinforcement Included in the Connector

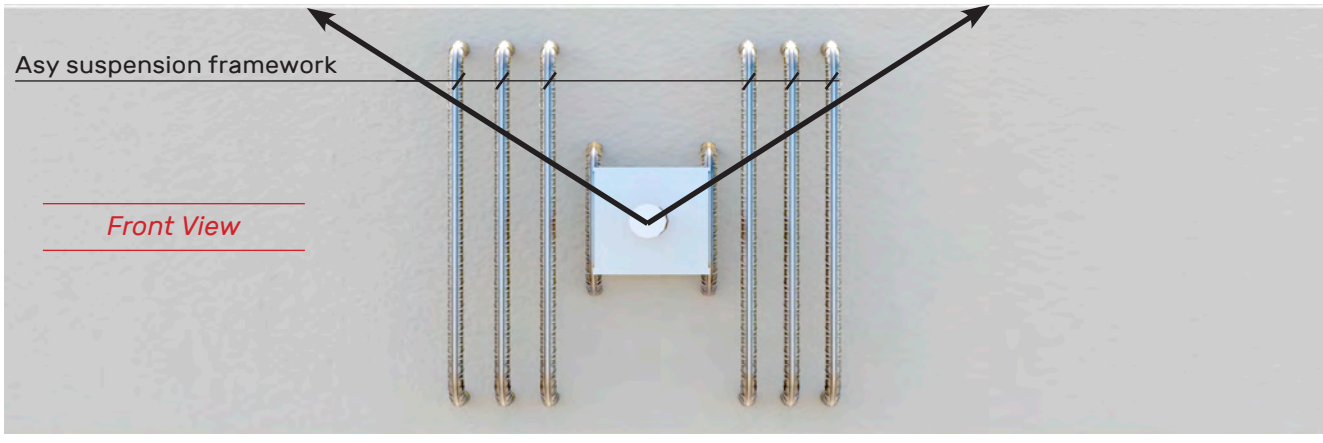
The local reinforcement included in the connector directly affects the stated resistance values of the connectors, as it enables a suitable distribution of forces and assists in the transfer of shear loads through the concrete.

Aesthetics are of no particular importance when designing the local reinforcement. The key is to have adequate concrete cover across all the elements. This requires it to be fully embedded in the connecting slabs.

4.1.7. Suspension Framework

The suspension reinforcement used on site directly affects the stated resistance values of the connectors, as it enables the transfer of shear loads from the concrete to the connector itself.

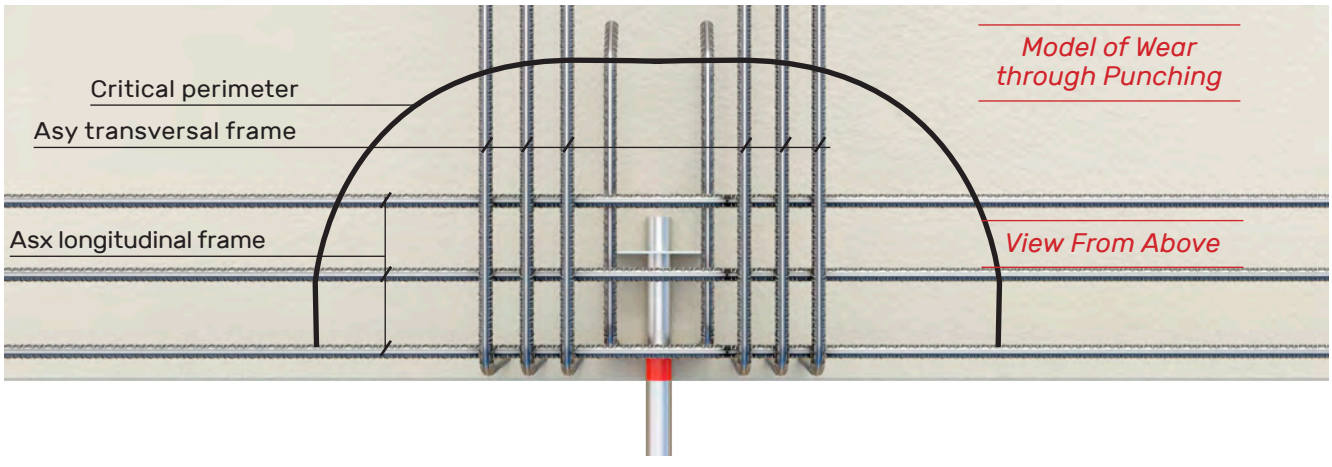
The manufacturer needs to provide the calculation of the required suspension reinforcement to achieve the stated connector resistance, as the lack of a reinforcement may cause premature failure of the system through breakage of the concrete closest to the connector.



4.1.8. Edge Beam Frame

The edge beam frame directly affects the resistance capacity of the system, as it conditions the maximum separation between connectors to prevent a failure through concrete punching in the gap between them.

4.2. Calculation Details



When calculating, it is important to know which data should be provided by the planner and which should be provided by the manufacturer of the connector.

The following table details which data should be provided by each of these:

System Elements	Planner	Manufacturer
Type of Concrete	X	
Slab Depth	X	
Joint Width	X	
Dowel		X
Sleeve		X
Local Reinforcement Included in the Connector		X
Suspension Framework		X
Edge Beam Frame	X	X

4.3. System Operation: Possibility of Freedom of Movement

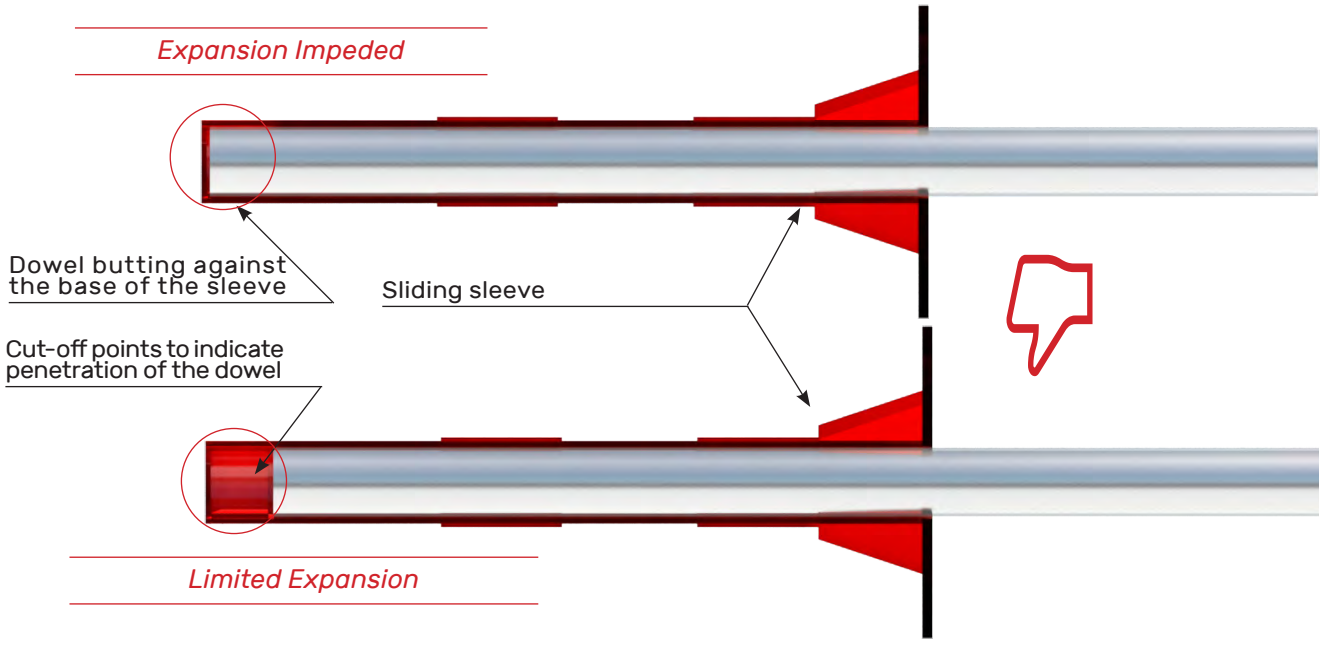
The structural joints are arranged to avoid additional tension caused by movements arising from expansion, primarily as a result of changes in temperature.

Thus, it is vital that the connected floors or slabs can actually expand freely. In the shear load connector systems, the sliding sleeve is the device specifically designed for this purpose. The following requirements need to be met:

4.3.1. Length Travelled Inside the Sleeve

The basic requirement of the sliding sleeve is that once the dowel for the shear load connector is installed within, it can move freely over enough distance in both directions to enable the intended movements.

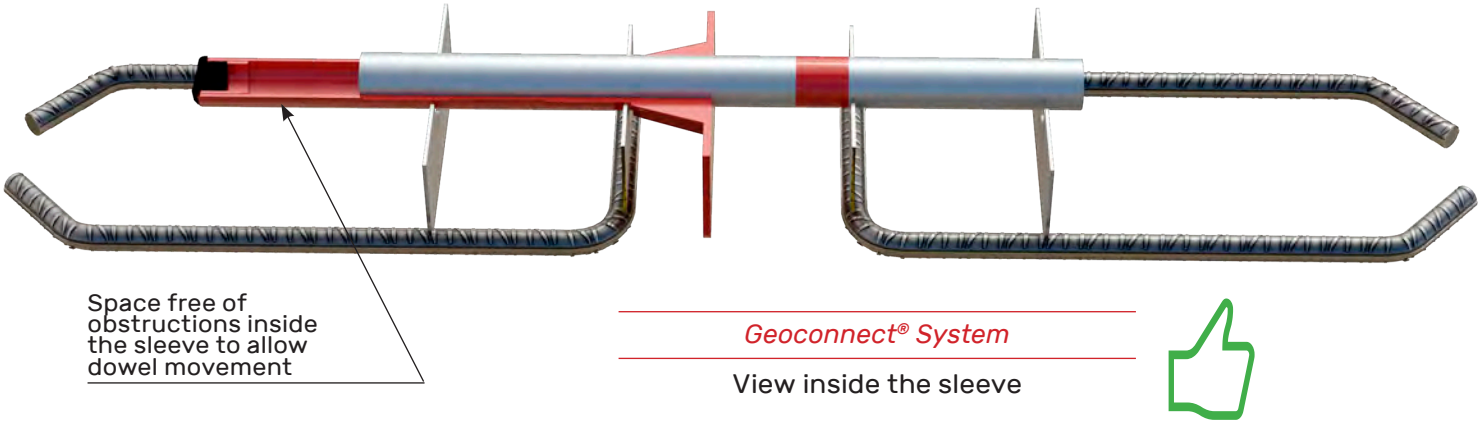
Design Errors: Constraint on the Free Movement of the Dowel



Attempting to have the dowel penetrate so that it butts against the base of the sleeve is a significant error. Also, if the system has physical limits to establish how far the dowel penetrates, these should not be housed inside the sleeve, as this would constrain the intended movement.

The inside of the sliding sleeves in the *Geoconnect® System* are free of limits and obstacles and are long enough for the dowel to move freely as required for the whole range of values intended for the width of the joint.

Geoconnect® Guarantee: Dowel with Freedom of Movement



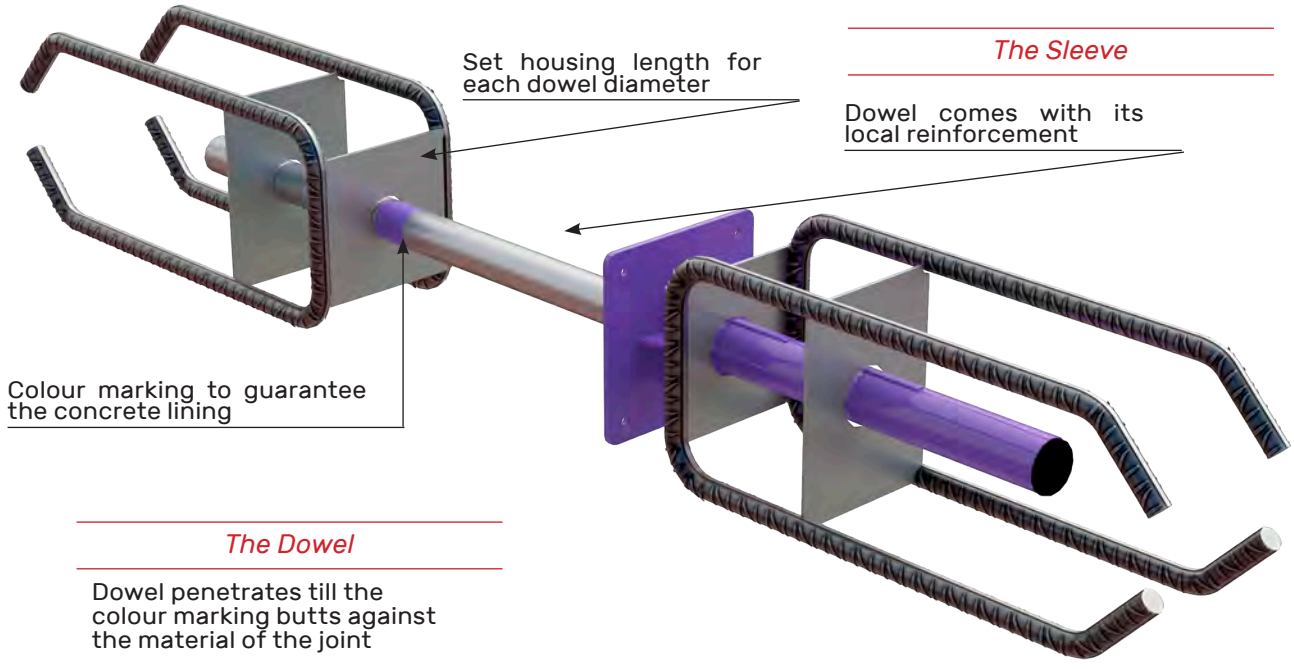
4.3.2. Geoconnect® Guarantee: Penetration of the Dowel in the Installation

The limits or marks which indicate the housing depth cannot be on the side of the sleeve as the length the dowel penetrates the sleeve will vary from case to case to allow for the necessary movement, depending on the expected joint width.

The limits or position markers must be on the side of the dowel, where the dowel is embedded in the concrete, as this is the fixed part of the system and the length the dowel penetrates on this side can be the same for all diameters, no matter the joint width, without this affecting the expected range of movements.

The *Geoconnect® LL System* provides the connecting dowel with the *Geoconnect® Reinforcement*, a local reinforcement with stiffened plates. This allows the right penetration length to be set on the dowel side without the risk of invading the area of sleeve required for the movement, for the full range of joint widths which can be used in the system.

The dowel comes with the *Geoconnect® SAO* colour marking to ensure the correct lining is used during installation.



4.3.3. Alignment of Sleeves in the Concreting Process

A key requirement to ensure the possibility of free movement is for the housing sleeves to remain in position throughout the concreting process for the slab or flooring in which they are housed.

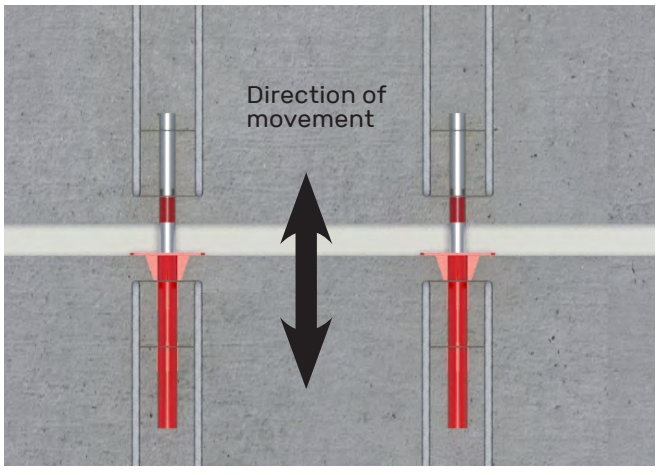
For a singular movement to be possible with joints between flooring or slabs, where a row of shear load connectors need to participate, it is vital for all the sleeves to be aligned in the same way, i.e. parallel both vertically and horizontally.

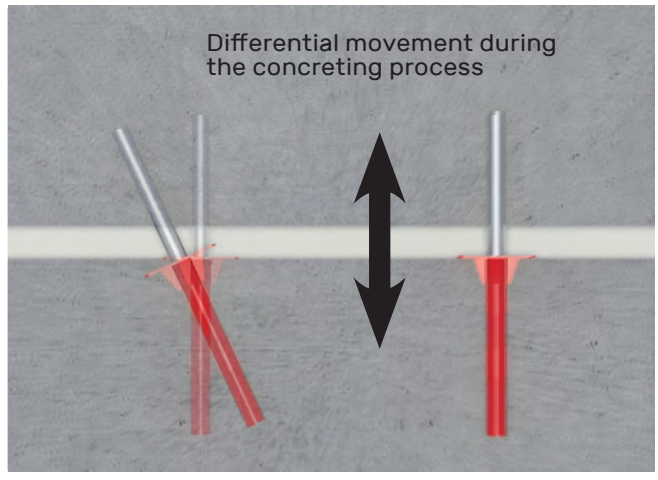
The sleeves can be correctly aligned during the assembly process, something which could and should be subject to careful inspection prior to concreting.

However, no matter how much care is taken to correctly position the sleeves during the assembly stage, it is impossible to guarantee that they will remain in place during the concrete pouring, vibrating and curing processes, when the sleeves are loose elements. The problem worsens because sleeve alignment cannot be checked after pouring the concrete.

Should the sleeves be turned or affected by differential movement (either sideways or up/down) during the concreting processes, then the expected freedom of movement cannot be achieved.

Holding the Sleeves Steady





Geoconnect® System

- Possible expansion

Joint with immobilised sleeves
(View from above)

Other Systems

- Expansion impossible

Joint with sleeves loose
(View from above)

4.4. Types of System Failure

A slab joint system using shear load connectors may fail through calculation errors, incorrect installation or defective design.

Types of System Failure	Cause	Solution
Punching	Insufficient depth	Increase framework
	Insufficient framework	
	Connector proximity	Increase distance between connectors / distance to edge
Breakage at edges	Insufficient depth	Increase reinforcement or reduce distance between frames
	Insufficient suspension framework	
Dowel Bending	Dowel diameter	Increase diameter or number of connectors
	Joint width	
Cracking due to Impeded Movement	Lack of space through sleeve	Suitable sleeve length
		Sleeve interior without obstacles
		Sleeve retained at three points

5. Differences between Connectors

Structural connectors can be used for different applications. Their features may vary depending on the purpose of the application, given critical failures are different.

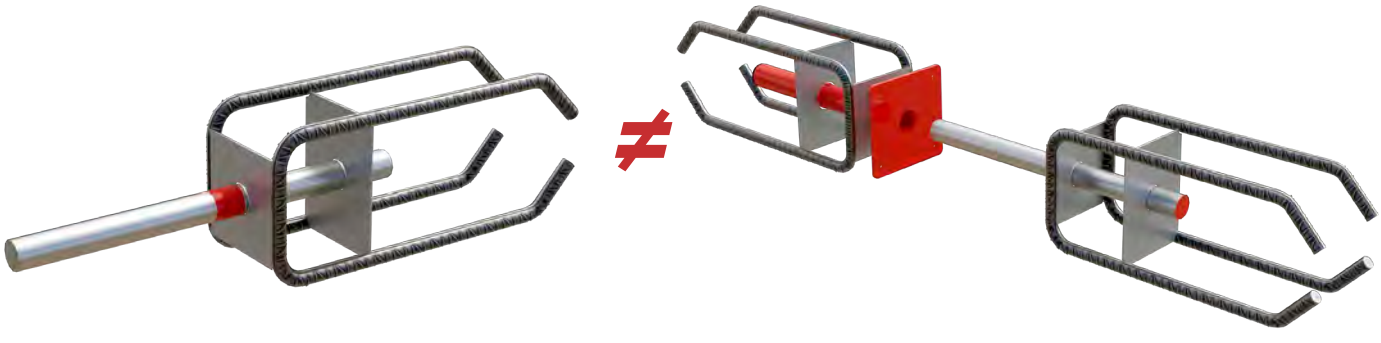
The table below summarises the main differences to take into account based on the type of use to prevent mistakes when choosing a connector:

Connection type	Horizontal Elements	Vertical and Horizontal Elements
	Connection of two elements with possibility of movement	Connection of two elements without relative displacement between them
Components	Two components	One component
Local Reinforcement Type	Two sides of the joint	One side of the joint
Extra Reinforcement	Possible reinforcement on the sides of the joint	Impossible to position distribution reinforcement in retaining/pile wall
Certificates	CE Marking DAU/ETA Certificate	DAU Certificate

5.1. Geoconnect® MP & LL: Difference in Connector Features

Geoconnect® MP shear load connectors to connect to retaining walls

Geoconnect® LL shear load connectors for flooring joints



With the *Geoconnect® MP* (connectors to join flooring to retaining or pile walls), the lack of a reinforcement close to the dowel within the retaining wall means the fault mainly happens as a result of support wear.

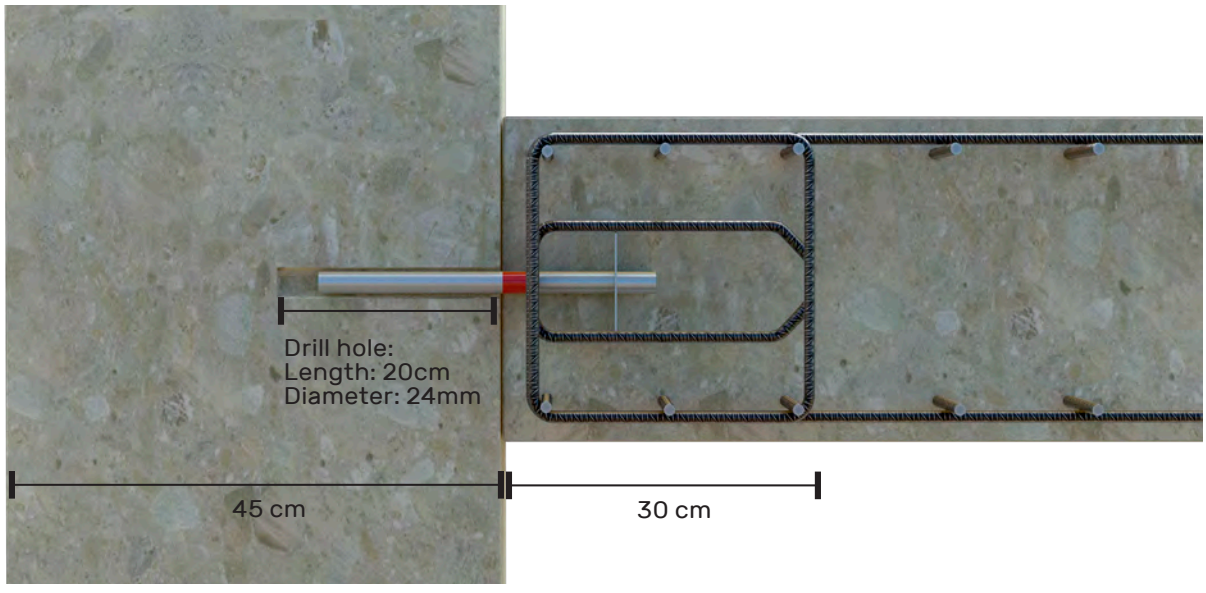
By contrast, with the *Geoconnect® LL* (connections for flooring with expansion joints), where the necessary reinforcement can be included, the fault occurs either through dowel wear or through slab punching.

As a practical example for a *Geoconnect® MP* and in accordance with information from testing undertaken in the Applus laboratories to obtain the DAU and ETA (CE Marking) certificates, the change in concrete quality from C25 to C35 increases the performance of the connector because it raises the resistance of the support, even in cases where the joint width is increased. By contrast, using a *Geoconnect® LL*, and making the same changes in concrete and joint width sees a fall in performance as the critical failure is different in each case.

Therefore, it is impossible to compare the performance of the *Geoconnect® MP* and *LL* connectors on an individual basis, but rather by considering the slab and joint system where they are found. One key factor that helps determine the performance correctly is whether the structural elements to be joined can be acted upon, or if one of them has already been implemented.

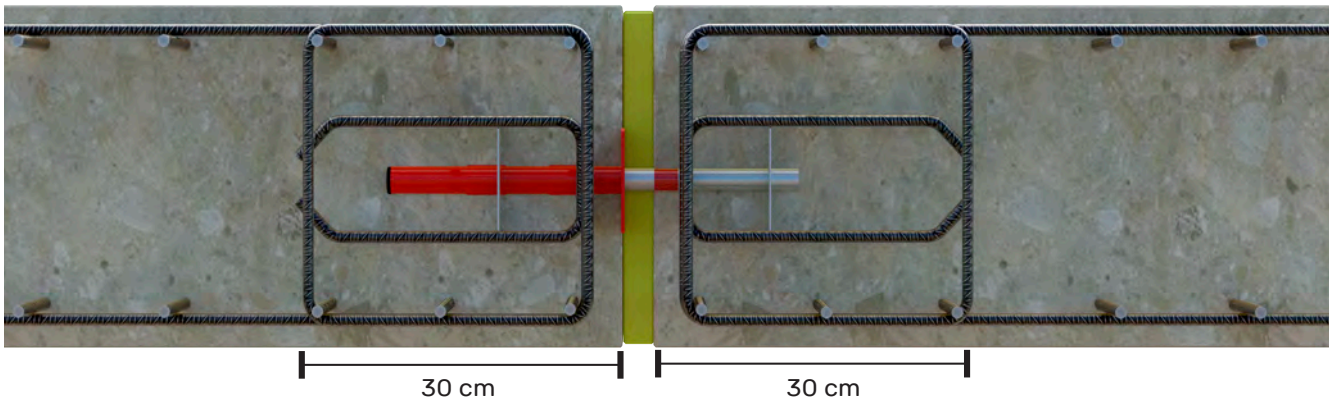
NOTE: Information endorsed by the testing undertaken in the Applus laboratories to obtain the DAU and ETA (CE Marking) certificates.

Example of the Difference in Shear Load Between Geoconnect® 20 MP and Geoconnect® 20 LL with 10mm and 20mm joints and C25 and C35 Concrete



For C25 at 30 cm deep with
10mm joint: Vrd=44.3kN

For C35 at 30 cm deep with
20mm joint: Vrd=46.7kN



For C25 at 30 cm deep with
10mm joint: Vrd=76.4kN

For C35 at 30 cm deep with
20mm joint: Vrd=65.4kN

5.2. Hybrid Connectors: WH & WM

Shear load connectors WH are used when one of the elements either side of the joint is already constructed. In this case the dowel is installed by drilling a hole into the cast element which allows additional reinforcement to be placed only on the side of the sleeve that is yet to be constructed.

Shear load connectors WM are used when the sleeve is placed without reinforcement on both sides because there is no room for it, or because it is a vertical element wall or pillar and there is no need for it. These shear load connectors are mainly used for wall joints.

If the intention is for joint movement, then the opening needs to be considered in the calculation and positioning of the sleeve for this purpose.

The WH and WM series enable the placement of a sleeve and a connection to a pre-existing concrete element.

6. Design Conditions

The *Geoconnect®* Shear Load Connectors are designed to achieve the maximum structural performance and the very best out of the connection system.

Mechanical performance is determined by the quality of the steel and the size of the dowel and frames, but it is vital to make sure all the metallic elements are properly embedded in the surrounding concrete and suitably covered.

In terms of effective movements among the connected structural elements, the system operates in accordance with the geometrical alignment of the connectors during installation and the existence of a space in the sleeve that is free of obstacles and ready for the desired movement.

These key requirements ensure the stated features of the *Geoconnect® System* are achieved through the exclusive design of each component comprising the connector.

6.1. Dowel Design

The dowel is the main element related to the resistance capacity of any structural joint system.

The dowel for *Geoconnect®* Shear Load Connectors is produced in high mechanically -resistant steel– in both galvanized and stainless finishes. This means a reduction in the number of units required for any particular structural feature, simplifying the assembly and installation process.

The wide range of sizes available for the *Geoconnect® System* dowel covers most typical structural joint situations in building work.

Dowel length is proportional to cross-section diameter in all cases. This is to avoid losing resistance capacity that would come from limited penetration depth.

6.1.1. Dowel Penetration Depth in Concrete

Load transfer across the structural joint generates notable localised tension in the concrete, which means the dowel requires a specific depth of penetration to counter this problem.

Dowel penetration depth into concrete is regulated by ETAG 030 "Guideline for European Technical Approval of Dowels for Structural Joints, which serves as a reference to obtain the CE marking, which states:

"*The necessary minimum penetration into concrete to ensure the dowel works properly is 6.5 times that of its diameter 'D'. This minimum length must be checked against the worst-case joint width. However, this minimum penetration may be reduced to '5xD' under the condition that the resistance capacity in load transfer is lowered... A penetration length of less than '5xD' is considered ineffective in shear resistance*".

6.1.2. Systems with a Loose Dowel and Penetration Limits in the Sleeve

The systems supplied with the loose dowel and penetration limit housed within the sleeve hampers the path of the dowel through the sleeve. In addition, the length needed for the joint width is achieved at the expense of the penetration length by the dowel, meaning the resistance capacity of the system is notably impaired.

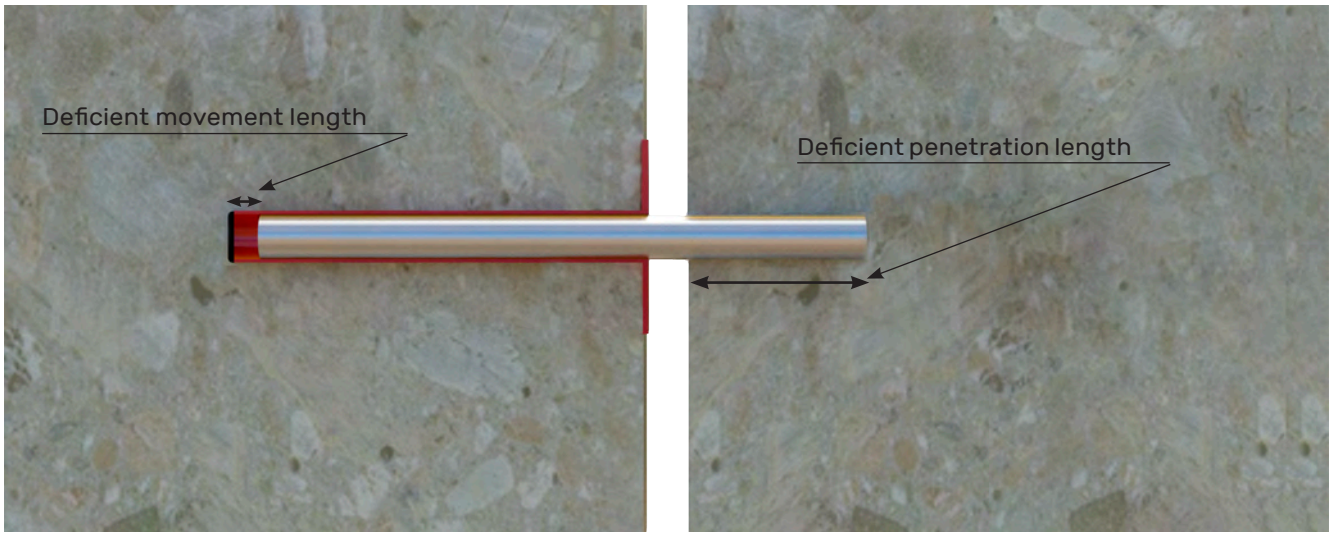
Simultaneous compliance with the two key requirements for a joint system with connectors (allowing movement and having the dowel penetrate sufficiently into the concrete) is achieved with the *Geoconnect® System* through a singular design, with the dowel and sleeve lengths calculated for this purpose.

To avoid possible on-site installation errors, the *Geoconnect® System* dowel is supplied attached to the local *Geoconnect® Reinforcement* with the exact penetration distance to avoid any loss in resistance capacity.

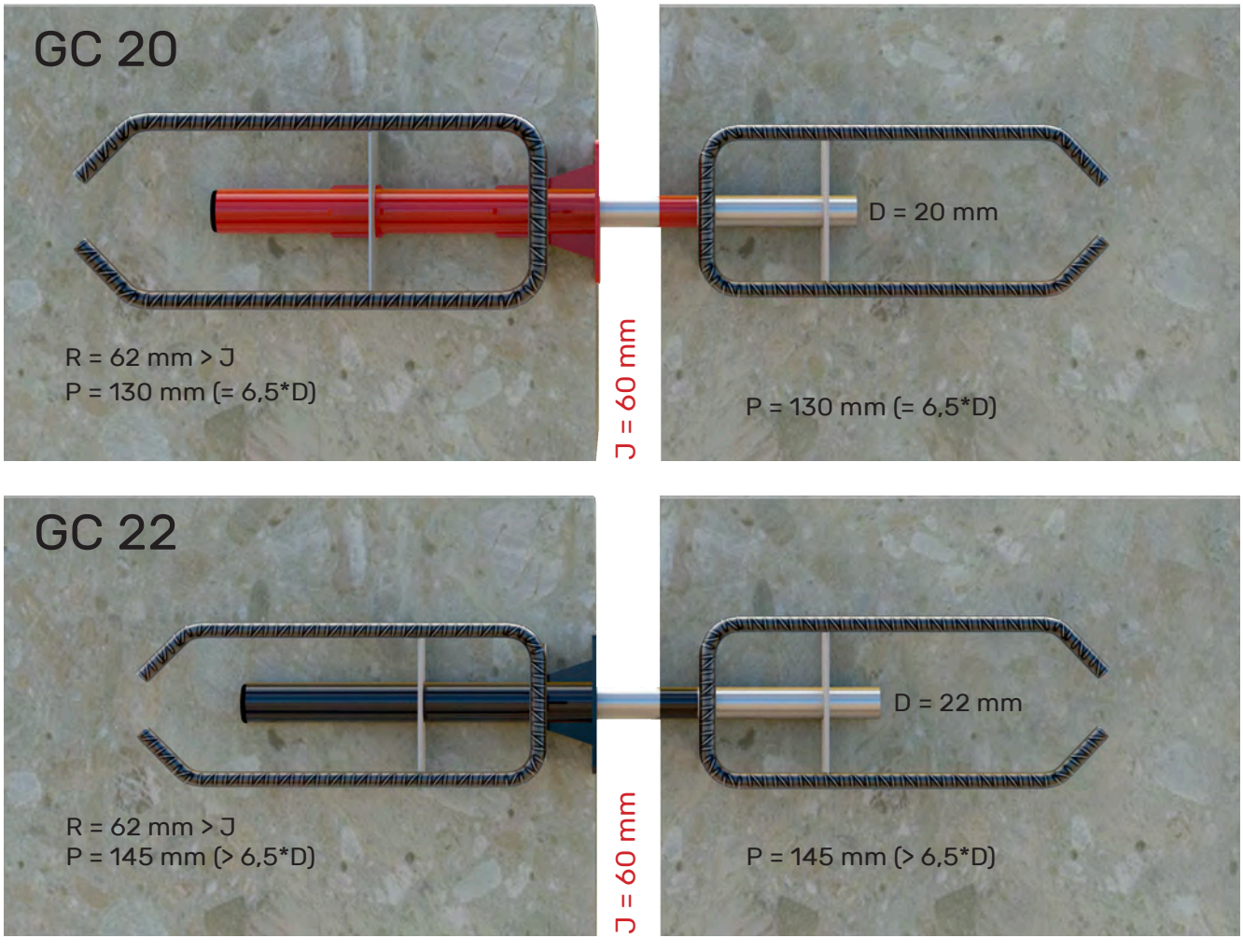
The minimum penetration length in all cases and on both sides of the joint is greater or equal to '6.5xD' to avoid any loss in resistance capacity from this issue.

Likewise, for the complete range of connectors, the length the dowel travels within the sleeve is greater than the expected joint width.

Systems with a Loose Dowel and Limits in the Sleeve

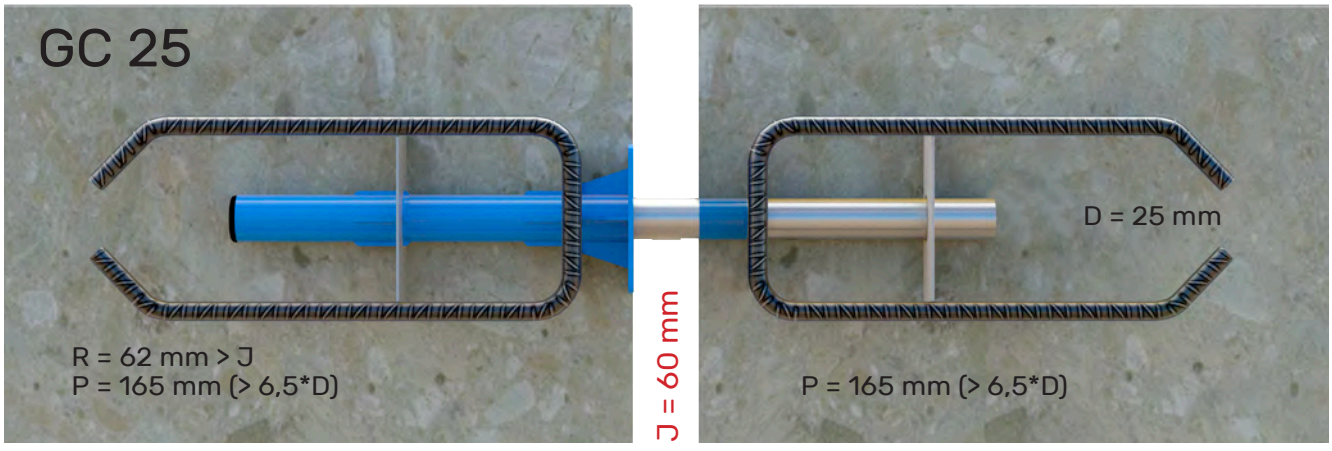


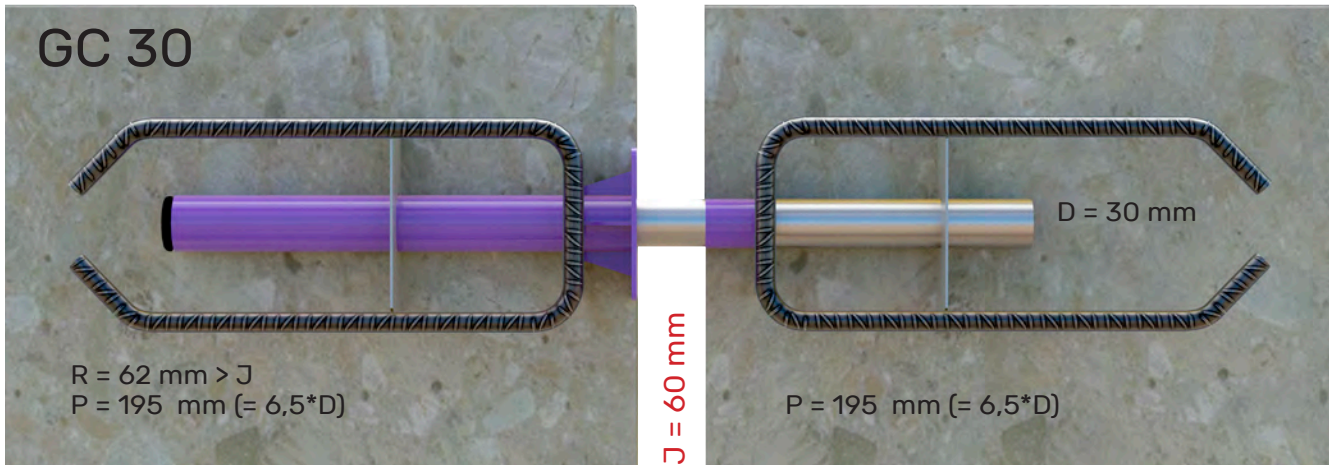
Geoconnect® System: Penetration Length and Path Travelled by the Dowel

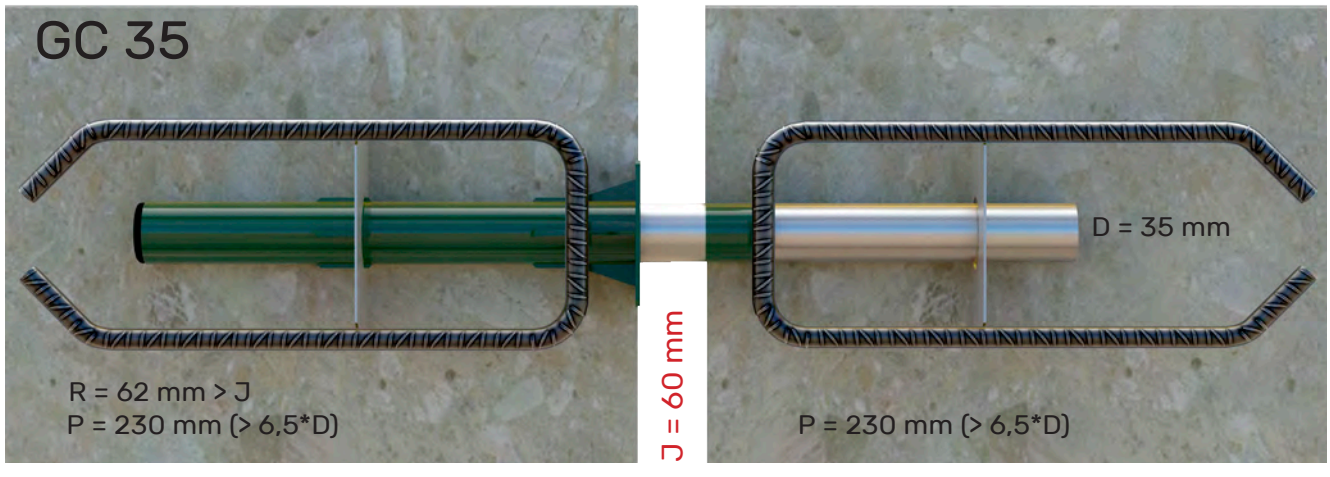


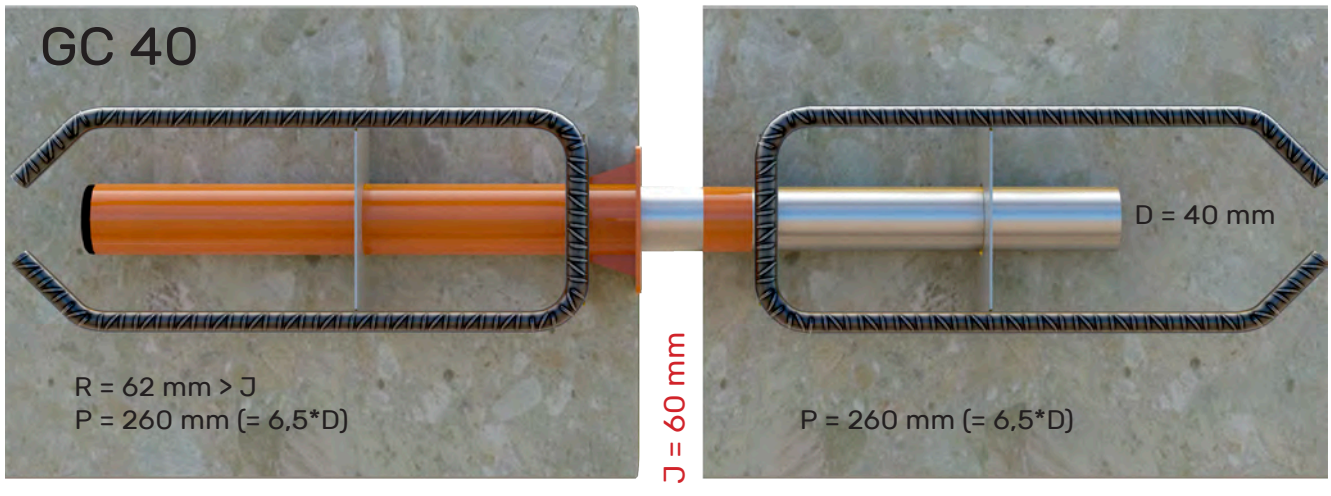
J – Joint width
P – Penetration length

R – Route length
D – Dowel diameter









J – Joint width
P – Penetration length

R – Route length
D – Dowel diameter

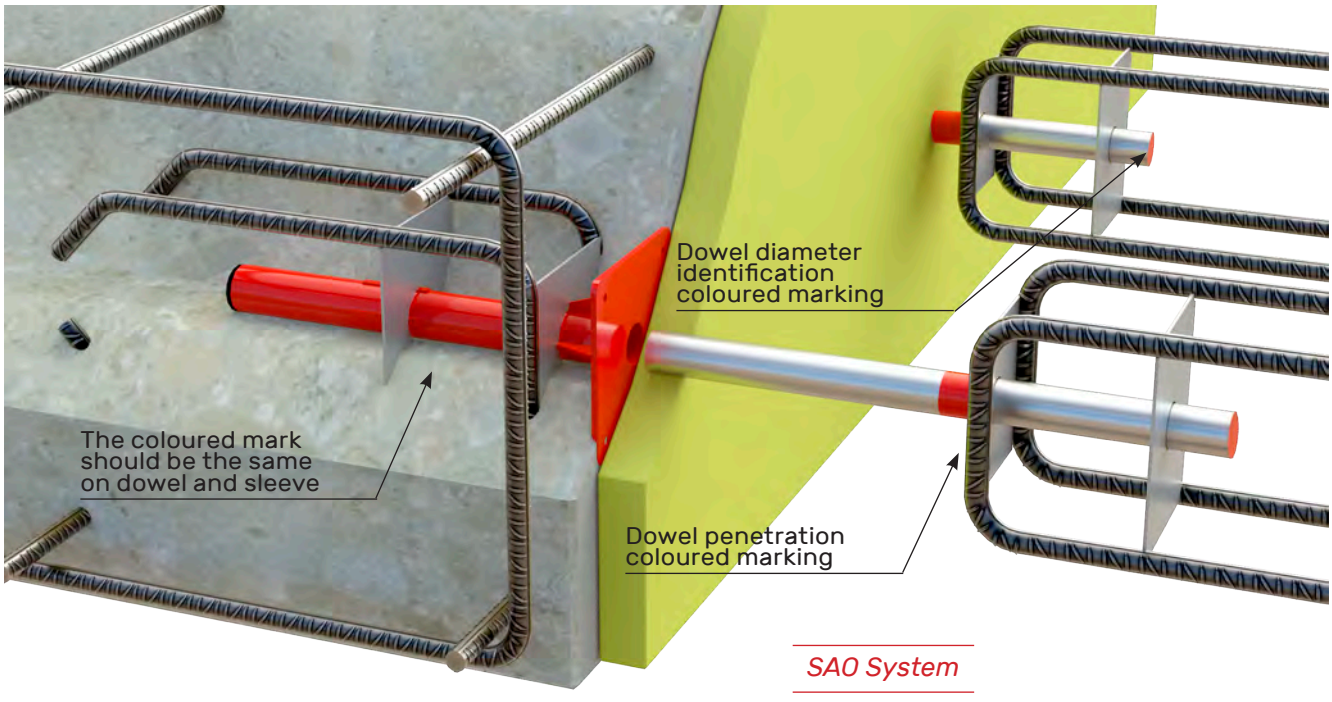
6.2. *Geoconnect® SAO* (Operator-Monitored System)

The design of the *Geoconnect®* Shear Load Connector includes the *Geoconnect® SAO System* which ensures correct installation and the best performance from the connectors.

The dowels are marked with a colour code, just like the sleeves, which serves to clearly identify connector diameters.

Likewise, the coloured marking on the dowel (3 cm wide) serves to insert the dowel to the correct depth in the slabs to ensure the mandatory covering.

Geoconnect® SAO (Operator - Monitored System)



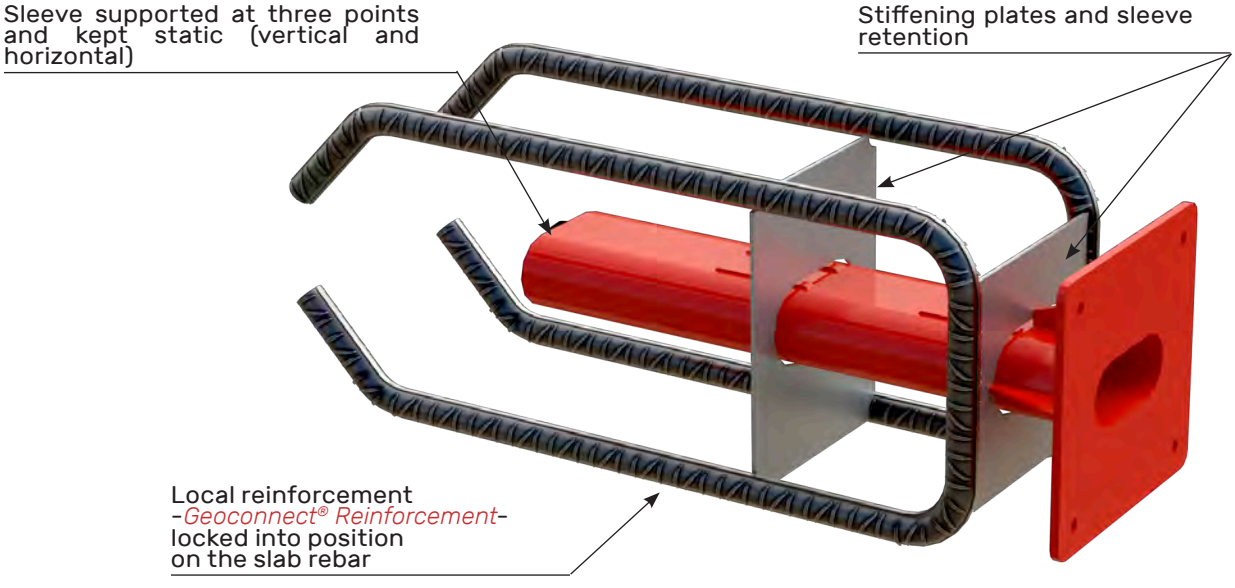
SAO System

6.3. Sleeve Design

Both the *Geoconnect® LL* System sleeves and dowels are attached to the local reinforcement (*Geoconnect® Reinforcement*), which are static elements in all directions thanks to their stiffened plates.

During assembly, the sleeves can be attached to and adjusted from the edge beam rebar with the certainty that they will remain in the correct place thanks to the rigidity of the supporting frame.

Geoconnect® System: Immobilised Sleeves (no movement in any direction)



6.4. Local Reinforcement Design

The *Geoconnect® Reinforcement* (local reinforcement) included with both the dowel and the sleeve comprise corrugated steel bars attached by means of frontal plates.

These elements are designed to be housed in the concrete so they are fully embedded, with the mandatory covering to ensure durability and enable forces to be transferred by proper adherence.

6.5. Range of Freedom of Movement

The range of intended movement for the structural elements separated by an expansion joint depends on the building's geometric and thermal conditions and, to a lesser extent, the season in which it is built.

The geometric parameter which defines this feature is joint width ("J"), which is filled with compressible material for the purpose.

The *Geoconnect® System* has a range of joint widths ("J") of 0 to 60mm (inclusive), although joint widths of less than 10mm will not be considered from a calculation and project specification perspective.

Joint widths are typically 20 to 40mm. Greater widths 40 to 60mm are reserved for areas with seismic issues requiring greater separation between contiguous structural elements. Shear load connector systems are not advisable for joints that are greater than 60mm wide even if the book value for the specified joint width is 0mm, calculations must been done with a minimum width of 10mm.

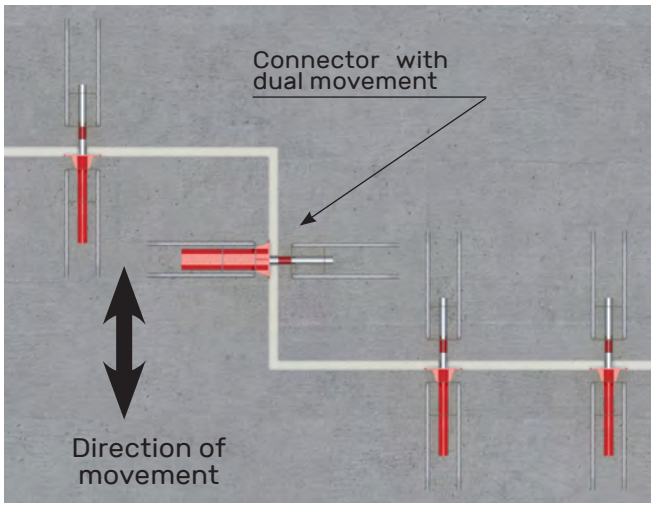
6.6. Dual Movements

The movement which must be enabled in a joint with shear load connectors is that contained at flooring level (normally horizontal) and perpendicular to the joint. However, there are situations which require freedom of movement parallel to the joint. These are for geometric configurations with floor breaks, i.e. joints in the shape of a "Z" or a "U".

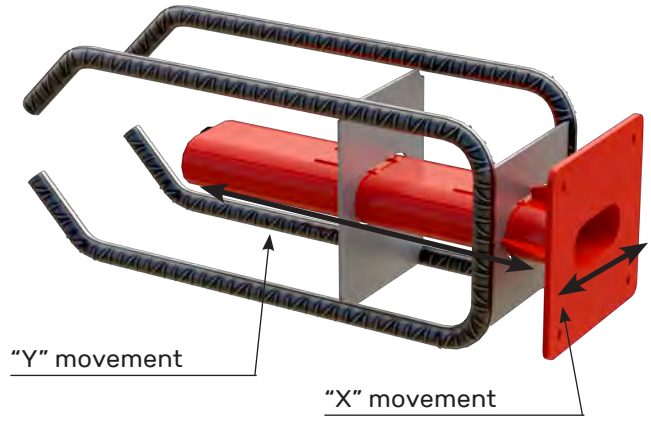
The *Geoconnect® System* has specific sleeves for dual movements (the "DM" series) in both plastic and stainless steel.

The maximum perpendicular movement allowed through the joint is 60mm and 26 to 36mm in parallel.

Expansion Joint with Floor Break

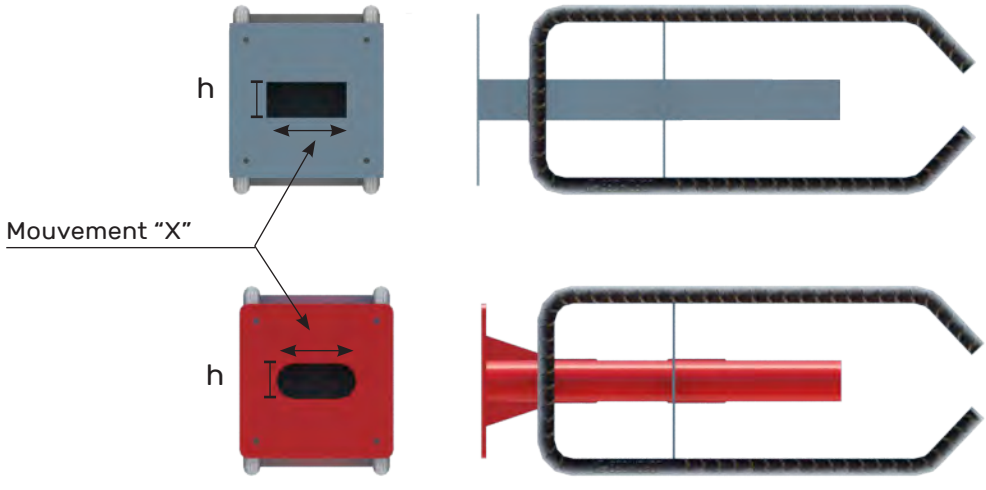


Geoconnect® Sleeve System with Dual Movement (DM-Type)



Stainless Steel Sleeve

Plastic Sleeve



7. Geoconnect® Fire: Fire Protection

The *Geoconnect® System* of structural shear load connectors can be used in cases where fire protection is required.

Fire resistance tests have been undertaken per EN:1365-2, classified as R120 in accordance with EN:13501-2.

7.1. Two Alternatives Available:

7.1.1. Individual Geoconnect® Fire Elements

The *Geoconnect® Fire* elements are designed to protect the dowel from the connector against fire as part of a joint solution that is project specific.

These elements comprise two layers:

- Layer of intumescent material which swells to 10 times its volume when exposed to high temperatures and seals the joint if there is a fire.
- Layer of rockwool which acts as a filler for the joint and provides a heat shield for the dowel.

For this to work properly, the difference between the joint width and the thickness of the *Geoconnect® Fire* element should be less than 10mm.

There should be a minimum 40mm concrete cover on the frame on the underside of the slab.

Dowel Diameter Ø	Dimensions (mm)	Nominal Thickness (mm)	Diameter of Inner Hole (mm)	Reference
20	160x160	22,5	21	GC Fire 2020
		32,5	21	GC Fire 2030
22	160x160	22,5	23	GC Fire 2220
		32,5	23	GC Fire 2230
25	160x160	22,5	26	GC Fire 2520
		32,5	26	GC Fire 2530
30	160x160	22,5	31	GC Fire 3020
		32,5	31	GC Fire 3030
35	170x170	22,5	36	GC Fire 3520
		32,5	36	GC Fire 3530
40	170x170	22,5	41	GC Fire 4020
		32,5	41	GC Fire 4030

7.1.2. Geoconnect® Fire: Comprehensive Joint Solution

Should a compartmental solution be required for the joint against fire, a comprehensive joint solution is proposed. This includes the following:

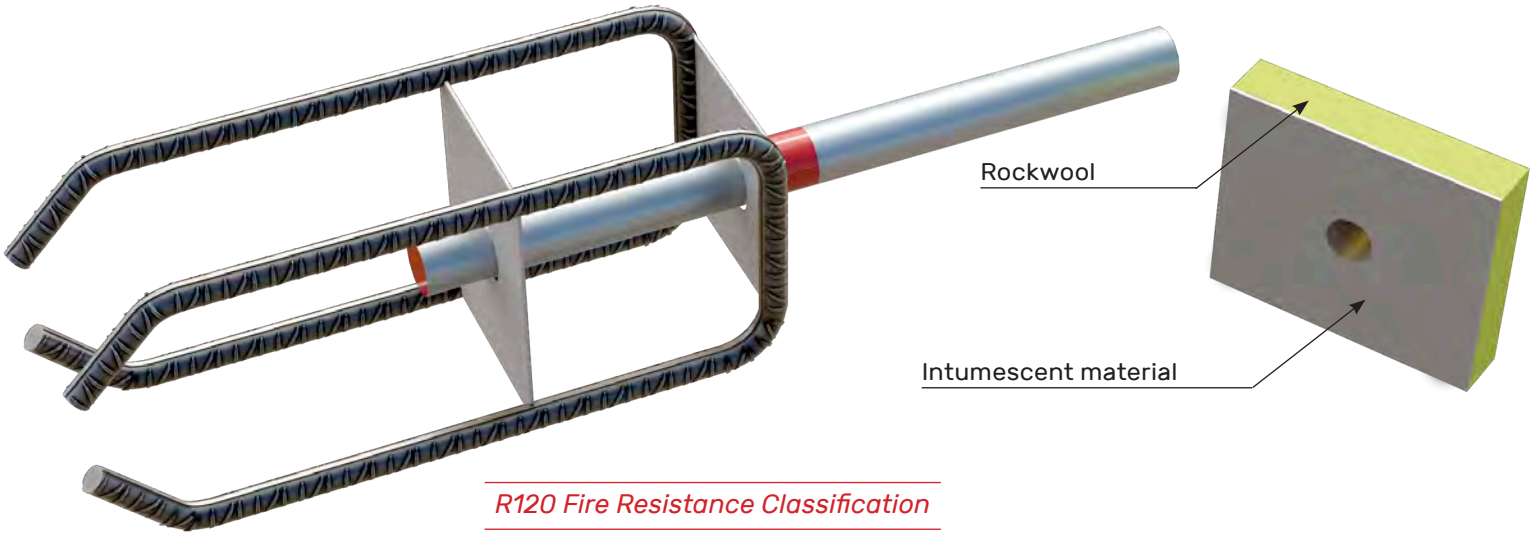
- *Geoconnect® Fire Joint*: Special pieces of rockwool with intumescent material (170mm high by 1200mm long), which should cover the entirety of the joint.
- *Geoconnect® Fire Elements*: Dimensions dependent on dowel diameter (as previously noted).

As with the solution comprised of just *Geoconnect® Fire* elements, the difference between joint width and the thickness of the *Geoconnect® Fire* element must be less than 10mm.

There should be a minimum 40mm concrete cover on the frame on the underside of the slab.

7.2. ETA 16/0064

Geoconnect® Fire elements include the ETA 16/0064 Approval and are the first solution certified with an ETA document in the structural connectors field.



R120 Fire Resistance Classification

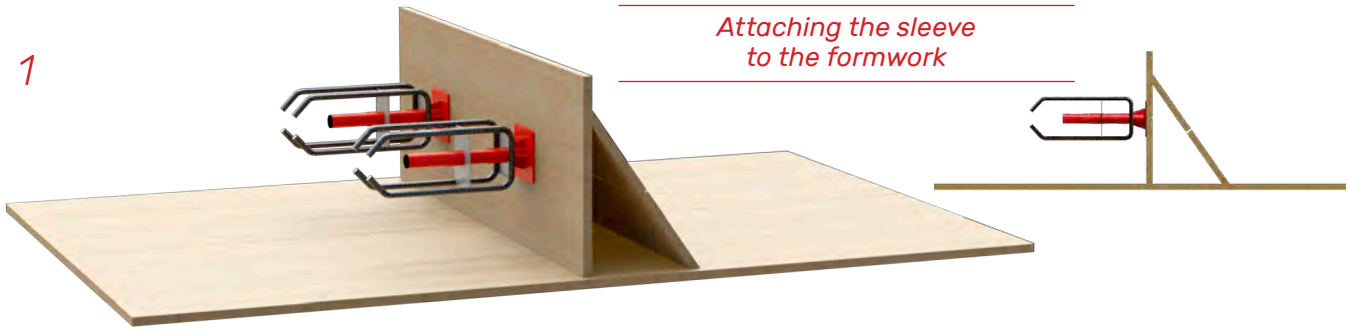
8. Example Geoconnect® LL Installation

In the first stage, the sleeve is attached to the formwork (1). For a *Geoconnect® LL* Shear Load Connector, this component includes a local reinforcement (*Geoconnect® Reinforcement*). The sleeve is surrounded by the frame of the edge beam and suspension reinforcement (2) and then the concrete is poured (3).

Once the formwork and the adhesive protection over the gap in the sleeve have been removed, the material to fill the joint is added (together with the *Geoconnect® Fire* protection elements, if required (4). Then the dowel is installed, inserting it into the sleeve (5), with the right dowel penetration ensured using the SAO system - right to the paint marking in contact with the joint material (porex) (6). Once the edge beam and suspension reinforcement are in place (7), concrete is poured in (8) and the installation completed (9).

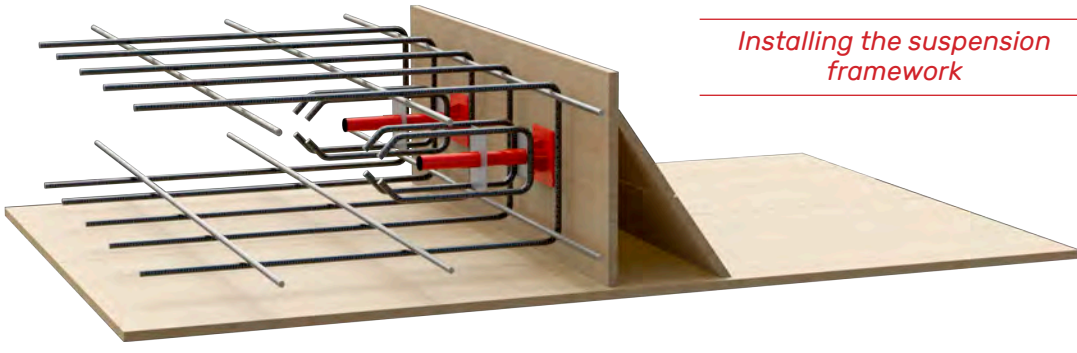
1

Attaching the sleeve to the formwork



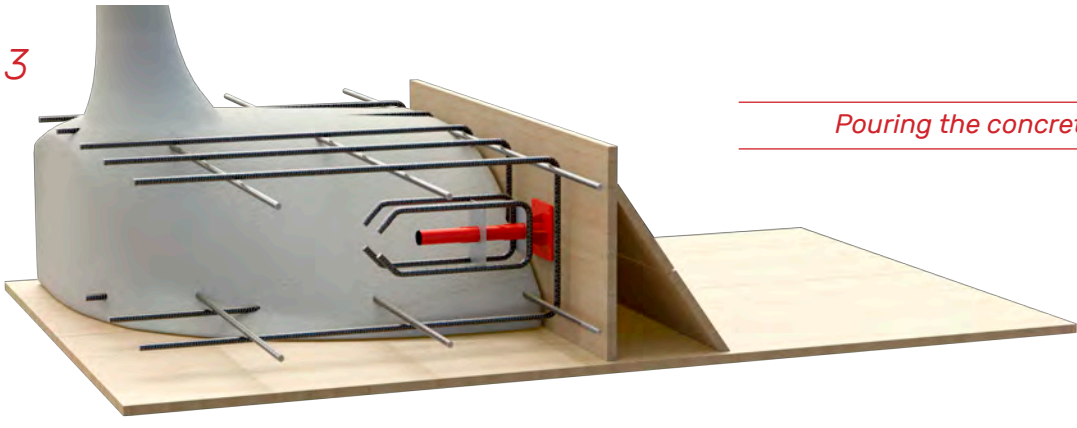
2

Installing the suspension framework



3

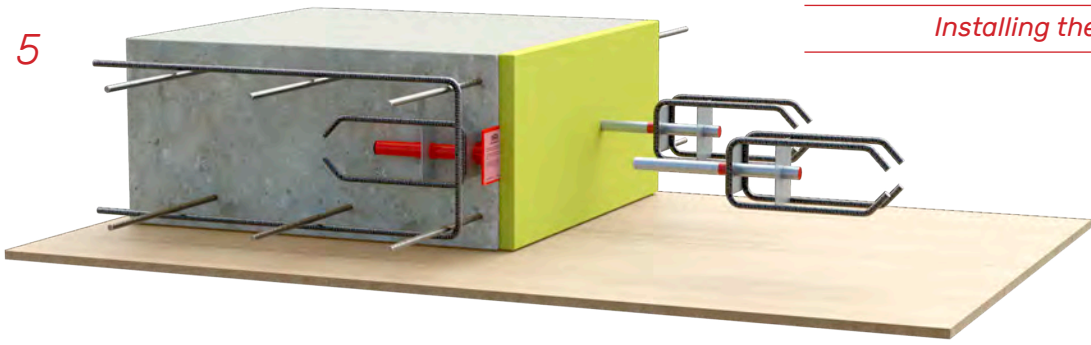
Pouring the concrete



4

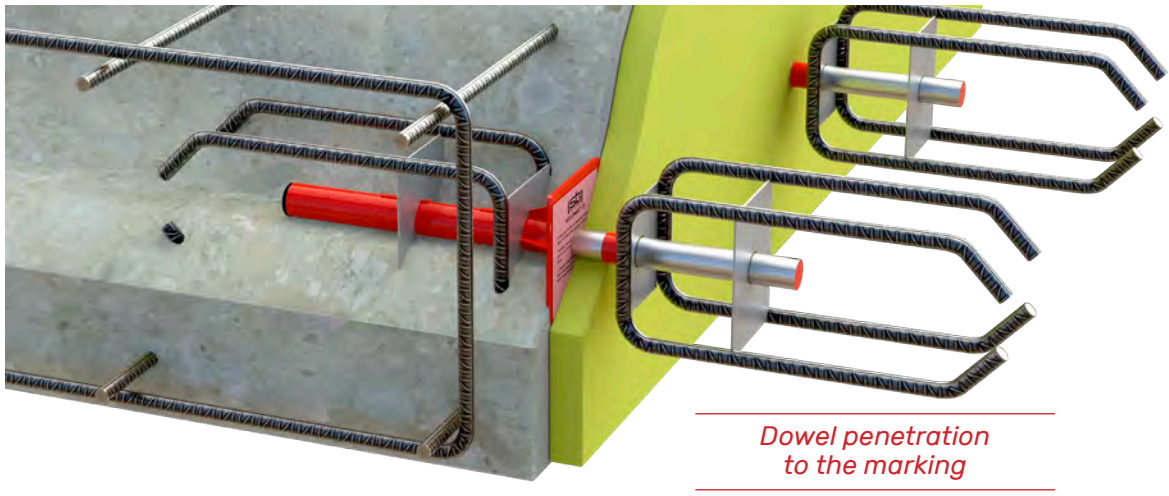
Removing the reinforcement and installing the joint material

5



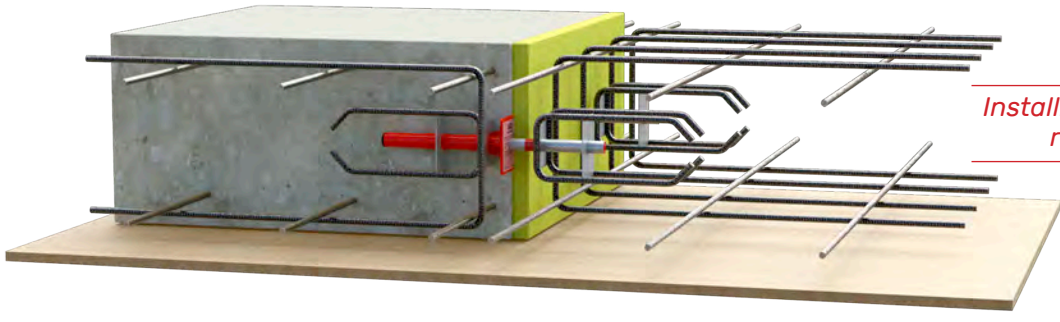
Installing the dowel

6



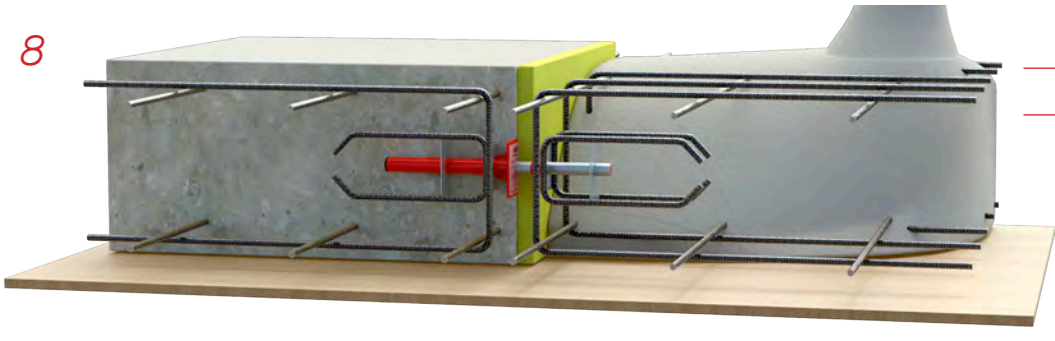
Dowel penetration to the marking

7



Installing the suspension reinforcement

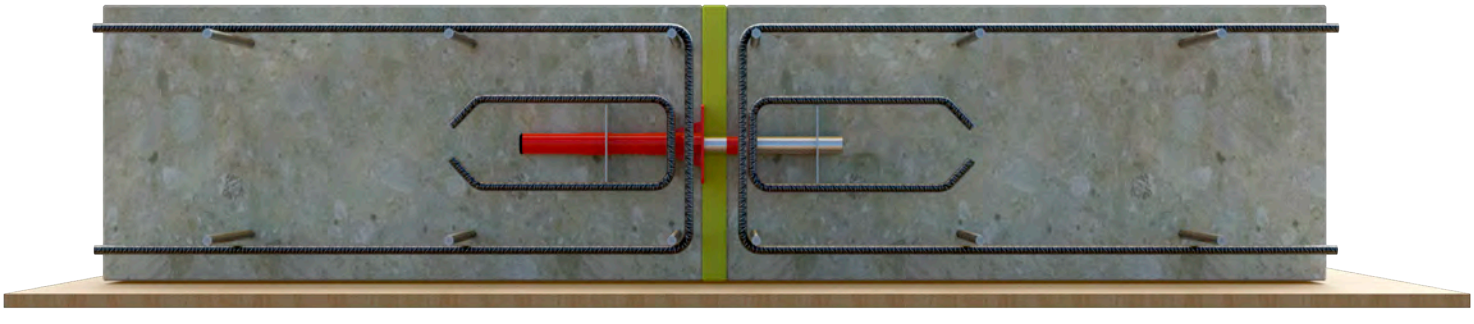
8



Pouring the concrete

9

Completion of the installation



9. Certificates

The *Geoconnect® LL* Shear Load Connectors have the first European Certification in this field (European Technical Assessment ETA 16/0064).

Based on this document, it has the corresponding CE marking.

The *Geoconnect® MP* Shear Load Connectors have the fitness for use document DAU15/095B.

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www.itec.cat

Member of EOTA
www.eota.eu

European Technical Assessment **ETA 16/0064 of 20.01.2016**

General part

Trade name of the construction product	**Geoconnect® LL**
Product family to which the construction product belongs	Dowel for structural joints
Manufacturer	**STEEL FOR BRICKS GZ SL** Polígono industrial Alfajarín-El Saco, parcela 10 ES-50172 Alfajarín (Zaragoza) Spain
Manufacturing plant(s)	Polígono industrial Alfajarín-El Saco, parcela 9 ES-50172 Alfajarín (Zaragoza) Spain
This European Technical Assessment contains	15 pages including 2 annexes which form an integral part of this assessment
This European Technical Assessment is issued in accordance with Regulation (EU) 305/2011, on the basis of	Guideline for European Technical Approval (ETAG) 030 *Dowels for structural joints. Part 1: General,* Edition April 2013, used as European Assessment Document (EAD)

DAU 15/095 B

Documento de adecuación al uso

Trade name

Geoconnect® MP

Holder of DAU

STEEL FOR BRICKS GZ SL
Polígono Industrial Alfajarín-El Saco, parcela 10
ES-50172 Alfajarín (Zaragoza)
Spain
Tel. +34 976 79 06 40

www.steelfb.com

Generic type and use

Dowel connector used to transfer shear loads between concrete structural elements: beams, slabs or floors to walls, piles or supports, without relative displacement between them.

Manufacturing plant

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Tel. +34 976 79 06 40

Valid edition and date

B 24.02.2016

CE

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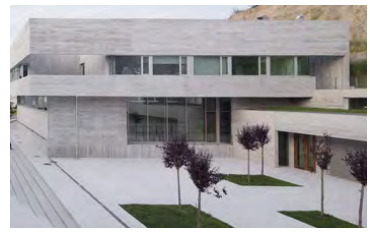
Tf.(+34)976790640/Fax (+34)976100597
-16-

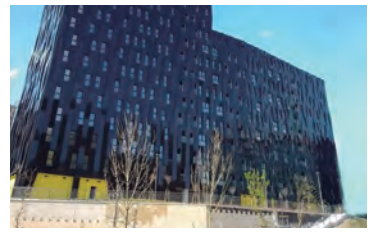
Nº Declaration of performance: **DPSFB-017**
Nº notified body: **1220**

ETA 16/0064, de 20.01.2016
Geoconnect® LL
Dowel connectors for structural joints

10. Project References

- Courthouse, La Rioja.
- Pepsi Cola Factory, Plant-Jeddah, Saudi Arabia.
- Puerto Riera Market, Plaza da Lonxa, Ribeira, La Coruña.
- Automated warehouse, RCR Engineering, Bolivia.
- Training and Conference Centre, Fuerteventura Los Pozos.
- Promenade, Puerto Rosario, Fuerteventura, Gran Canaria.
- Services & Recycling Centre for the new BBVA Bank Headquarters, Las Tablas, Madrid.
- Microsoft Ireland Dublin Campus.
- 218 flats in Arroyo Fresno.
- 162 flats in Los Balcones del Golf, calle Arroyo del Monte, s/n, Madrid.
- New Banco Popular Headquarters, Calle Juan Ignacio Luca de Tena 10, Madrid.
- Barajas Airport, Paving for Runways 18R-36L, Terminal 4, Barajas, Madrid.
- Rafael Nadal High Performance Centre, Manacor, Majorca.
- Valenza Health Centre, Ourense.
- Corporate Offices for Real Madrid Football Club, Madrid.
- 60 flats in El Juncal, Alcobendas, Madrid.
- Hotel Elke, Gerona.
- Telefónica Headquarters Car Park, Las Tablas, Madrid.
- 184 flats in Batlo Magoria, Barcelona.
- 38 flats in Los Coronales, Madrid.
- 72 flats in Valdebebas, Valenor, Madrid.
- The Tiffany's Building, Andorra.
- La Querola Building, Andorra.
- Montehigueldo Amusement Park, San Sebastián-Donostia, Guipúzcoa.
- University Hospital, Ourense.
- Antequera-Granada High-Speed Train (AVE) Station, Antequera, Malaga.
- Courthouse, Pontevedra.
- Plaza Mayor Shopping Centre, Malaga.
- Geluidsschermen Nieuwe Leeuwarderwegweg, Amsterdam, Holland.
- Marina Port Premiá de Mar, Barcelona.
- 40 flats in Arroyo Fresno, Madrid.
- Block of flats, Isla Chamartín, Madrid.
- Panama Underground Line 2, San Miguelito Station, Panama City, Panama.
- Torrecárdenas Shopping Centre, Almeria.
- Residential Building, Txomin Enea, Guipúzcoa.
- 81 flats in Benalmádena, Malaga.
- Bolueta Tower.
- Bolueta Tower (Phase 2).
- 100 flats in Ensanche de Barajas.
- 129 flats in Valdebebas, Valenor.
- Sao Paulo Underground, Guarulhos Station, Sao Paulo, Brazil.
- Nursing Home, Plasencia, Cáceres.
- 143 flats at calle Narcís Roca, 5, Barcelona.
- 171 flats in Gesurbe, Torrelodones.
- Expansion of Santa María la Blanca School.
- New administrative Building, Civil Works, Continental Mabor-Lousado, Vila Nova de Famalicão, Portugal.
- 172 flats in Los Prunos, Zaragoza.
- Residential Building at calle Ramón y Cajal, 218, Terrassa, Barcelona.
- Iberdrola Campus Phase II, San Agustín de Guadalix, Madrid.
- Marina Port Office Building, Premiá de Mar, Barcelona.
- Base Coex, Andorra.
- Plaza Mayor Shopping Centre.
- Iberdrola Campus - Phase II.
- Gran Casino Aljarafe, Seville.
- Hotel Los Urrutias, Murcia.
- Inmoglaciar, 87 flats, Tarragona.
- Caleido Tower, Madrid.





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