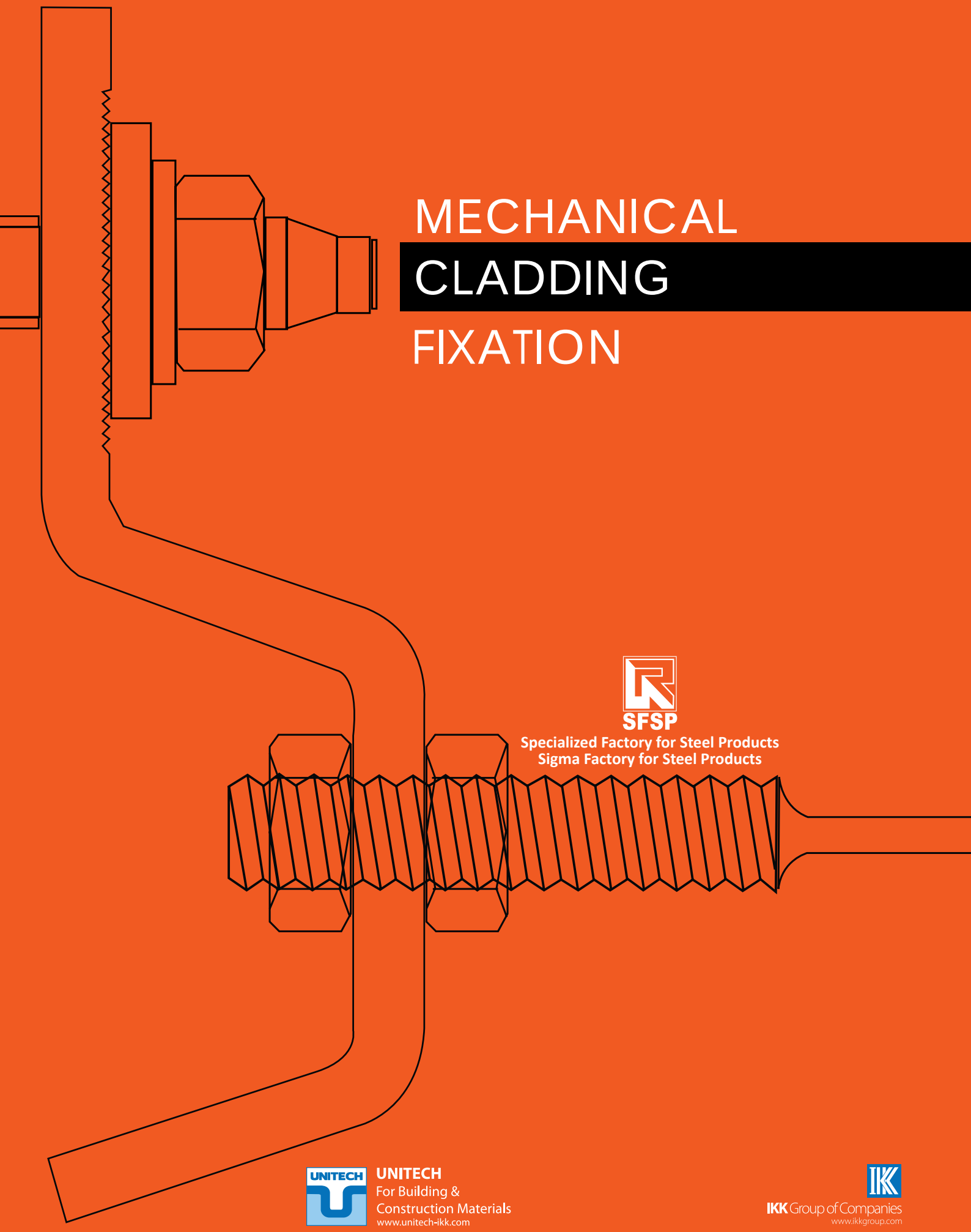
MECHANICAL CLADDING FIXATION



SFSP
Specialized Factory for Steel Products
Sigma Factory for Steel Products

UNITECH
For Building &
Construction Materials
www.unitech-ikk.com

IKK Group of Companies
www.ikkgroup.com

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INTRODUCTION

INTRODUCTION

The IKK Group is a major business institution, serving most of the Arab World in the Industrial, Construction and Trading fields as well as in Specialized Maintenance and Services. After almost four decades in the business, the IKK Group has become one of the leading enterprises in the region with focus on the Construction Industry in general.

Today, the Group is a pioneer in Waterproofing, Weather proofing, Building Material Supplies, Construction Steel Products, Manufacturing and the Fabrication and Sales of UPVC, CPVC and High Density Polyethylene Pipes and Fittings. As well as the sales of Sanitary Products, Accessories and many other items and technologies used in the industry.

It is Composed of 34 companies; The IKK Group operates through almost 200 divisions, branches and outlets, spread over 16 countries, covering all major cities in the region and employing over 10,000 employees.
The IKK Group has been recognized as one of the Top 40 Companies in Saudi Arabia for the past ten years.

www.ikkgroup.com

Unitech is part of a big enterprise which is the IKK Group of companies (www.ikkgroup.com). As an active member in the group, Unitech has been able to occupy the second position in terms of revenues within the group and continues to dominate a large geographical presence.

Following the construction boom, Unitech has had several successful strategic growth through its diversified range of products and its geographical expansion that covers the major parts of the GCC and MENA region reaching the heart of Europe. This expansion enabled unitech to target revenues of US $ 190 million in 2010 with 1259 employees in total.

Unitech has always been a customer-driven company; the corporate culture that exists within Unitech consists mainly of professionalism and team work. The diversification environment in terms of its products and systems leads unitech to ensure a green life for its customers based on the principles of the quality and environmental management system.

www.unitech-ikk.com

INTRODUCTION

UNIMETAL

Uni-Metal, an affiliate of Unitech, trades steel construction products including expanded metals, cladding fixations, c-channel systems, clamps & hangers, block ladders, dry wall and ceiling accessories, cable management systems, cable trays, cable ladders, cable trunkings, basket trays, cable supports, steel lintels and block work accessories.

Most are designed and manufactured in its Specialized Factory for Steel Products (SFSP); which is a leading manufacturer and fabricator of steel and aluminum products in KSA, UAE and Egypt.

Uni-Metal offices are spread among various cities in the MENA region; KSA, UAE, Qatar, Lebanon, Jordan, Libya, Oman, Bahrain, Egypt, Kuwait and Yemen; all are backed up by Unitech's design office in Stuttgart, Germany.

www.unimetal-ikk.com

SFSP

Specialized Factory for Steel Products was first established in KSA in 1989 and has been expanding ever since through a variety of products and through its geographical presence. Production at the factory is observed using modern practices of manufacturing methods in the steel construction industry with a definite compliance to the international standards of fabrication.

SFSP has manufacturing facilities in KSA, UAE, Egypt and Lebanon. SFSP adapts quickly and easily to the market demands and requirements. The use of advanced building products, and especially steel products for the construction industry is witnessing a rapid development.

Quality at SFSP is uncompromised; the factories have been able to acquire ISO 9001: 2008 in Jeddah in Saudi Arabia, Sigma Factory for Steel Products in Ajman in UAE, in addition to ISO 14001 : 2004 in the 6th of October City in Egypt.

www.sfsp-ikk.com

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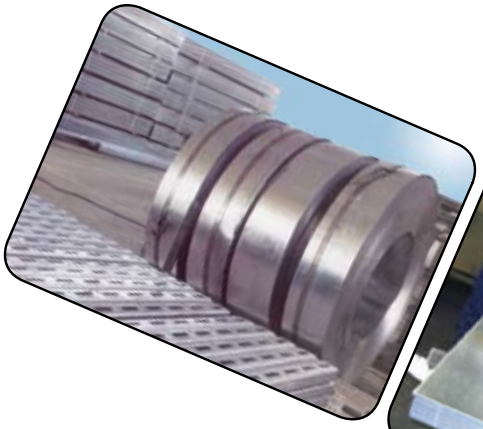
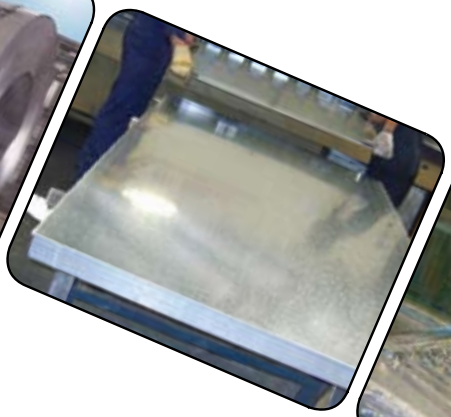
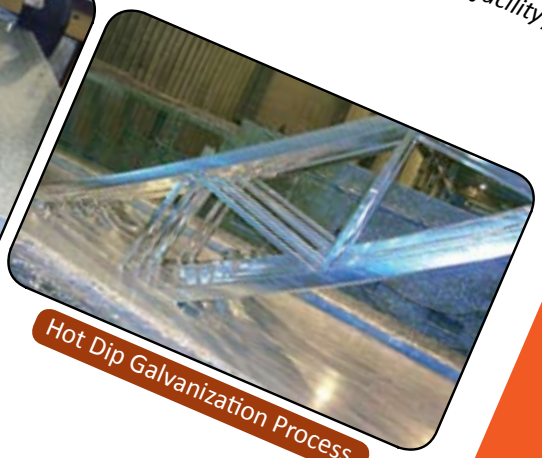
U.S. GREEN BUILDING COUNCIL
USGBC

SFSP is a leading manufacturer and fabricator of steel and aluminum products, ranging from cable management system to mechanical fixations, c-channel system, block work and plastering accessories, drywall profiles, and several other items used in the construction industry. Our customers have access to the most complete systems that can be offered.

(Our factory is equipped with an in-house hot-dip galvanization facility) .



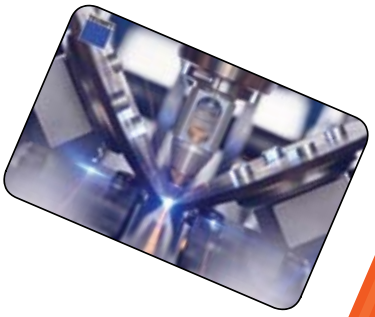




Hot Dip Galvanization Process

CNC Machines

Roll Forming Machine



UNITECH OUTLETS

Uni-Metal trades in-house produced steel construction products, all designed and manufactured in SFSP plants located in KSA, UAE and Egypt.

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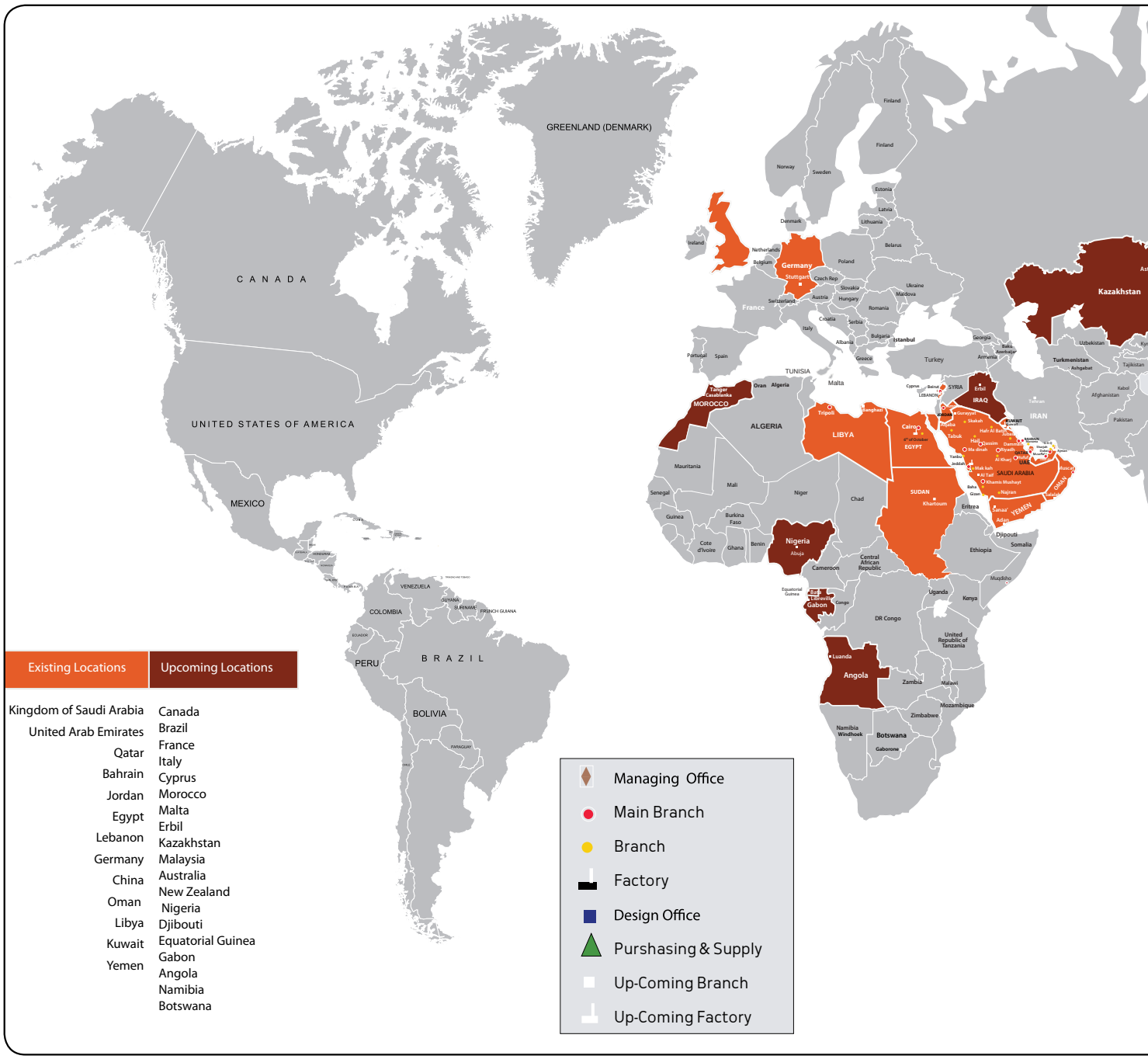

Existing Locations	Upcoming Locations
Kingdom of Saudi Arabia	Canada
United Arab Emirates	Brazil
Qatar	France
Bahrain	Italy
Jordan	Cyprus
Egypt	Morocco
Lebanon	Malta
Germany	Erbil
China	Kazakhstan
Oman	Malaysia
Libya	Australia
Kuwait	New Zealand
Yemen	Nigeria
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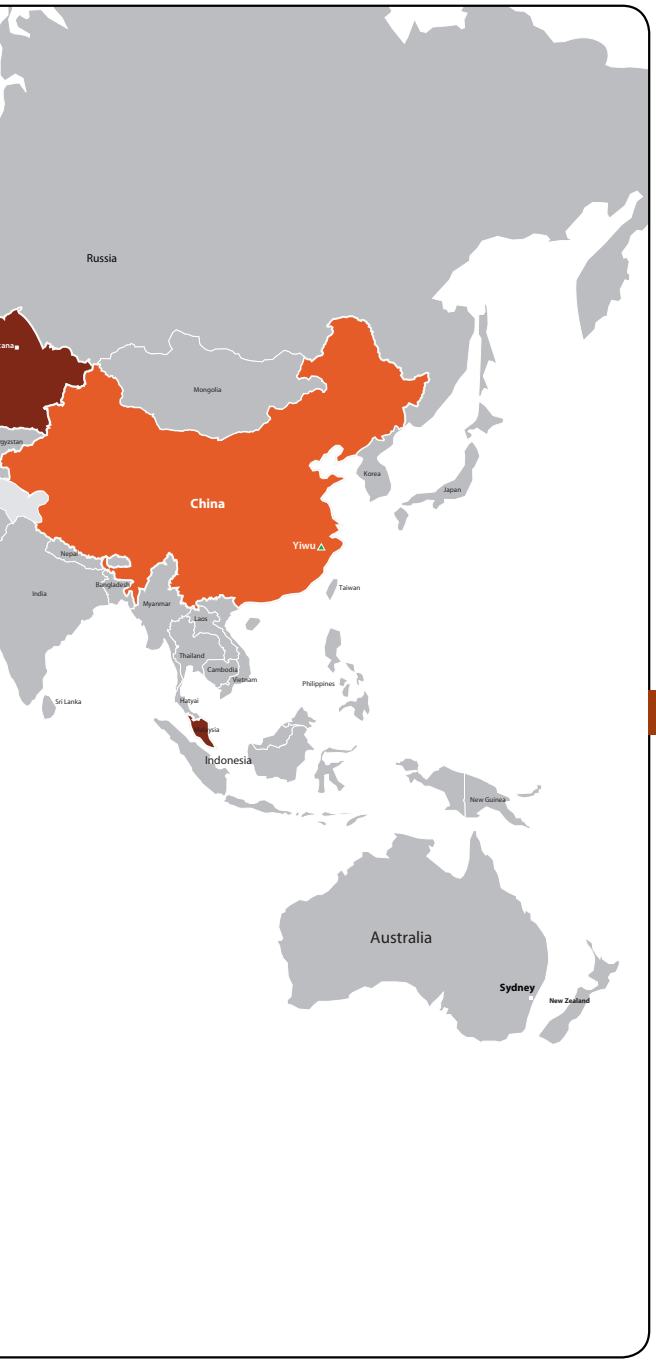

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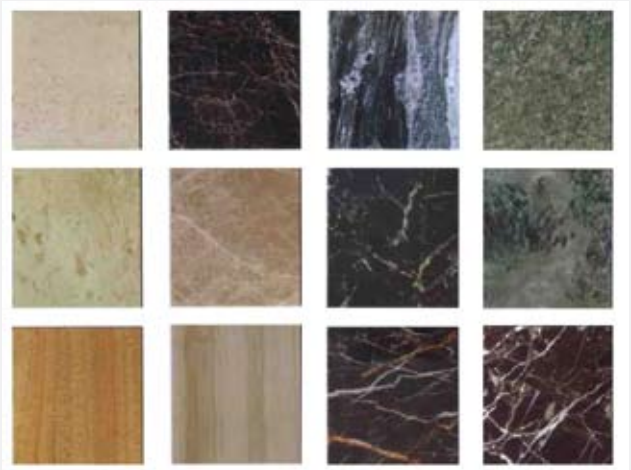
TECHNICAL INFORMATION

Types of Stones

The most common types of stones are:
- Marble.
- Travertine.
- Granite.
- Slate.
- Limestone.

Natural stones are rich with color combinations. The variety of colors and textures is huge.

The very common finishes are:
- Polished, Honed, Bush Hammered and Sandblasted for Marble.
- Polished, Honed, Flamed and Sandblasted for Granite.



Marble

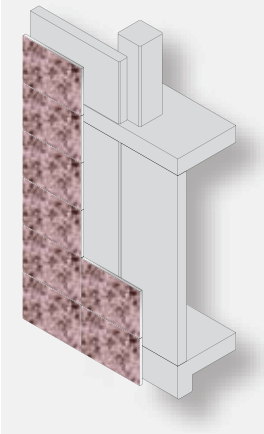
Travertine

Granite

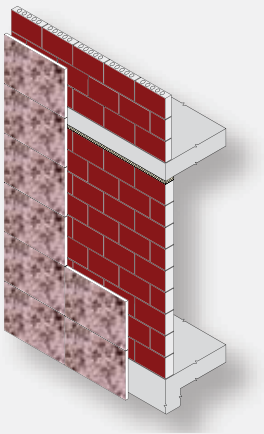
Slate and Limestone

Types of Facade Building Sub-Structure

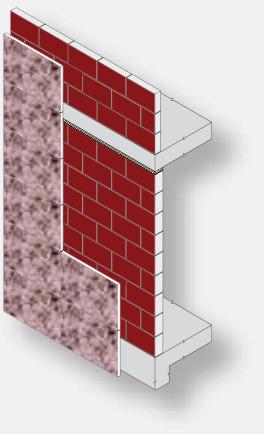
- Stone fixed to concrete wall
- Stone fixed to hollow block wall
- Stone fixed to solid block
- Stone fixed to composite substructure



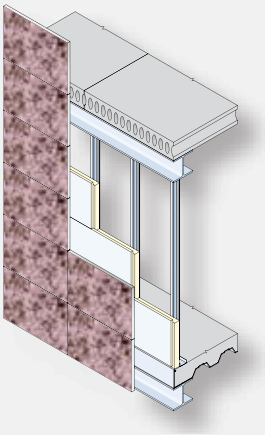
Stone fixed to concrete wall



Stone fixed to hollow block wall



Stone fixed to solid block wall



Stone fixed to composite substructure

General Background to Different Stone Facades

When natural or reconstituted stone has been chosen as a cladding material. It is necessary to give consideration to the following key areas for the purposes of choosing the most appropriate fixing system:

1) Type of structural material (e.g. concrete/block)
2) Design of cavity (e.g. ventilated/full fill insulation)
3) Design of stone joint (e.g. open/closed)
4) Size of stone (e.g. thickness/panel size)
5) Design duration of building

Required Thickness of Stone Cladding

Thickness of stone and depth of slot for corbel panel												
Stone location	Stone type											
	Stone thickness t* in mm				Min. thickness of stone behind a pin				Min. depth of slote for a corbel plate, d			
	G Mw Sl Q	T LsH	Mb	Ls Ss	G Mw Sl Q	T Ls H	Mb	Ls Ss	G Mw Sl Q	T Mw Sl Q	Mb	Ls Ss
Cladding (external)												
Less than 3.7 m above ground or floor level and continuously supported (incl. fascias)	20	20	20	50	7	7	7[2]	25[3]	Not applicable			
Fascias less than 3.7 m above ground or floor level (incl. fascias)	30	30	NA	50	12	12	NA	20[3]	20	20	NA	25[3]
More than 3.7m above ground or floor level (incl. fascias)	40	40	NA	75	15	15	NA	30[3]	25	25	NA	37[3]
Soffits (including inclined soffits)[4]	40	40	NA	75	15	15	NA	30[3]	Not applicable			
Sills, copings and supported reveals	30	30	NA	50	12	12	NA	20[3]	Not applicable			
Stone faced concrete units	30	30	NA	50	Not applicable				Not applicable			
Lining (internal)												
Less than 7 m above ground or floor level and continuously supported (incl. fascias)[5]	20	20	20	50	7	7	7[2]	20[3]	Not applicable			
Less than 7 m but more than 3.7m above ground or floor level on corbels in slots (incl. fascias)	30	30	NA	50	12	12	NA	20[3]	20	20	NA	25[3]
More than 7m above ground or floor level (incl. fascias)	30	40	NA	75	12	15	NA	30[3]	20	25	NA	37[3]
Soffits (including inclined soffits)[4]	40	40	NA	75	15	15	NA	30[3]	Not applicable			

1) Abbreviations

G Granites
Ls limestones (e.g. Portland, Bath, Clipsham)
LsH Hard limestones (e.g. Roman stone)
Mb Brecciated marbles
Mw Homogeneous marbles
Q Quartzites
SL Slates (those unlikely to delaminate).
Ss Sandstone (e.g. York, Northumberland, Scottish)
T Travertine

2) Breciated marbles may need to be reinforced with block liners but in assessing the minimum thickness of stone behind a cramp mortise the thickness of the block liner should be ignored.

3) Half thickness if stone is more than 75 mm thick.

4) The figures in the table apply to soffit stones not exceeding 900mm x 600mm. If stones of a greater size are required consider that some changes may happen to using some face fixings and/or additional fixings in the length and/or increased thickness. Internal soffit stone not less than 1.2m and not more than 3.7m above floor level, continuously supported at reveals may be 20mm thick for G, Q, SL, T, LsH, Mw and 50mm for Ls and Ss.

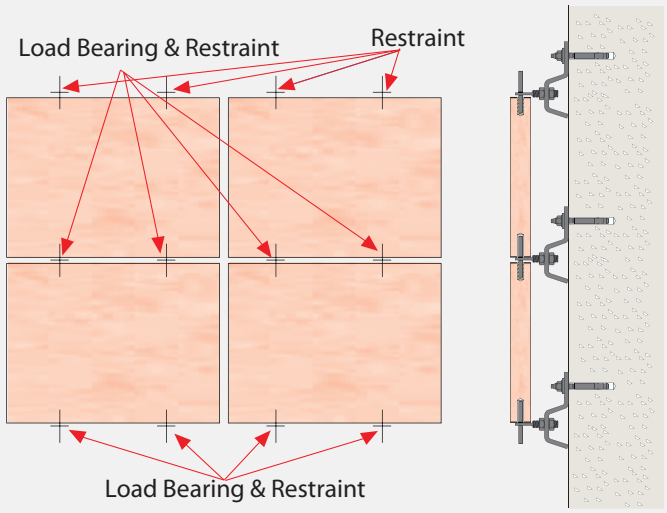
5) Internal cladding between 3.7m and 7m in height in a continuous face has to have an intermediate corbel course.

Table based on BS 8298 stone thickness table

FIXINGS IN HORIZONTAL OR VERTICAL JOINTS

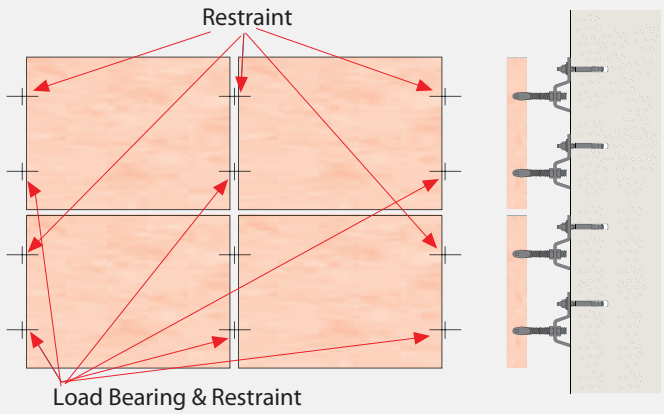
Fixation in a Horizontal Joint

Brackets carry half of the weight of the natural stone slabs when installed horizontally. Brackets bear half the weight of the slab above and also act as restraints, holding the slabs below and restraining them against wind pressure and wind suction.



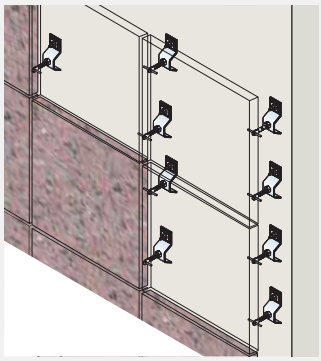
Fixation in a Vertical Joint

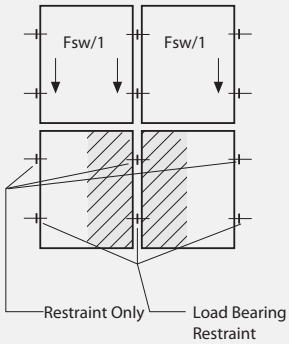
Load bearing carry the full weight of the natural stone slab in vertical installation. Each bracket bears half the weight of the slab on the right and half the weight of the slab on the left. Restraint brackets hold the slabs below and restrain them against wind pressure and suction.



Installation at vertical joints

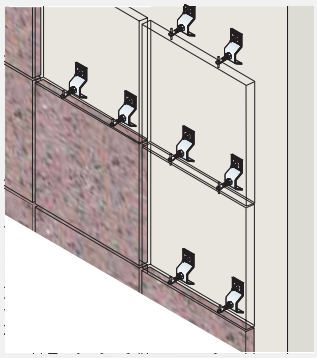
$Fv=\frac{Fsw}{1}$

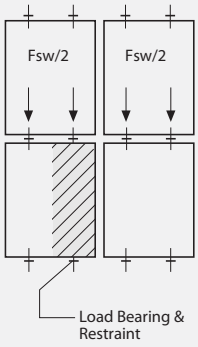




Installation at horizontal joints

$Fv=\frac{Fsw}{2}$





Determining the Vertical Loading Fv

Fsw = self weight of natural stone panel

a) Using two support bracket in vertical joint: One bracket carries the self weight (dead load) Fsw=Fv

Example :
Panel dimentions = (width x height x thickness) = 600x1000x40mm
Density of Natural Stone = 27 kN /m^3
Dead Load = 0,6x1x0,04x27kN/m^3= 0,65kN
Self weight per panel: Fsw = Fv =0,6m x 1,0m x 0,04m x 27kN/m^3 = 0,65kN = 65kg

b) Using two Support brackets in horizontal joint: One bracket carries the half of the self weight of a natural stone panel .

Example:
width x height x thickness 600x1000x40mm
Natural-stone panel b/h/s = 0.6/1.00/0.04/m
Self weight = 0,6x1x0,04x27kN/m^3= 0,65kN
Load on one bracket = Fv = Fsw/2= 0,65kN/2 Fv=0,35kN
Density= 27 kN/m^3
Anchor loading Fv= Fsw /2= 0,65kN72=0,33 kN
Fv= vertical Loading on one bracket.

Determining the Horizontal Loading Fh FH(Wind Loading)

Example:
Natural-stone panel = 600x1000x40mm
Wind pressure =Wp = Cp x W
W= wind stagnation pressure (velocity pressure) W= 1,10kN/m^2
W= 1,10 kN/m^3 for Building height 20-100m
Cp= Aerodynamic coofficient = 0,8
Wind pressure= Wp=0,8 x 1,10kN/m^2 = 0,88 kN/m^2
wind load on panel = W_l = 0,6m x 1m x 0,88kN/m^2 = 0,53 KN
Horizontal loading on bracket = Fh= W_l/2= 0,53/2= 0,27 KN
One anchor carries the wind loading of half of a natural-stone panel
by using two brackets in one joint

Metals Used in Fixing Systems

Metals used for the realization of the various components comprising the fixing system shall possess special features which, in addition to assuring a satisfactory mechanical resistance, shall also be immune to the varying forms of corrosion, in order to withstand both the static and dynamic load conditions to which they are subject throughout installation and the harmful atmospheric conditions which may arise as well, with extreme sturdiness and security.

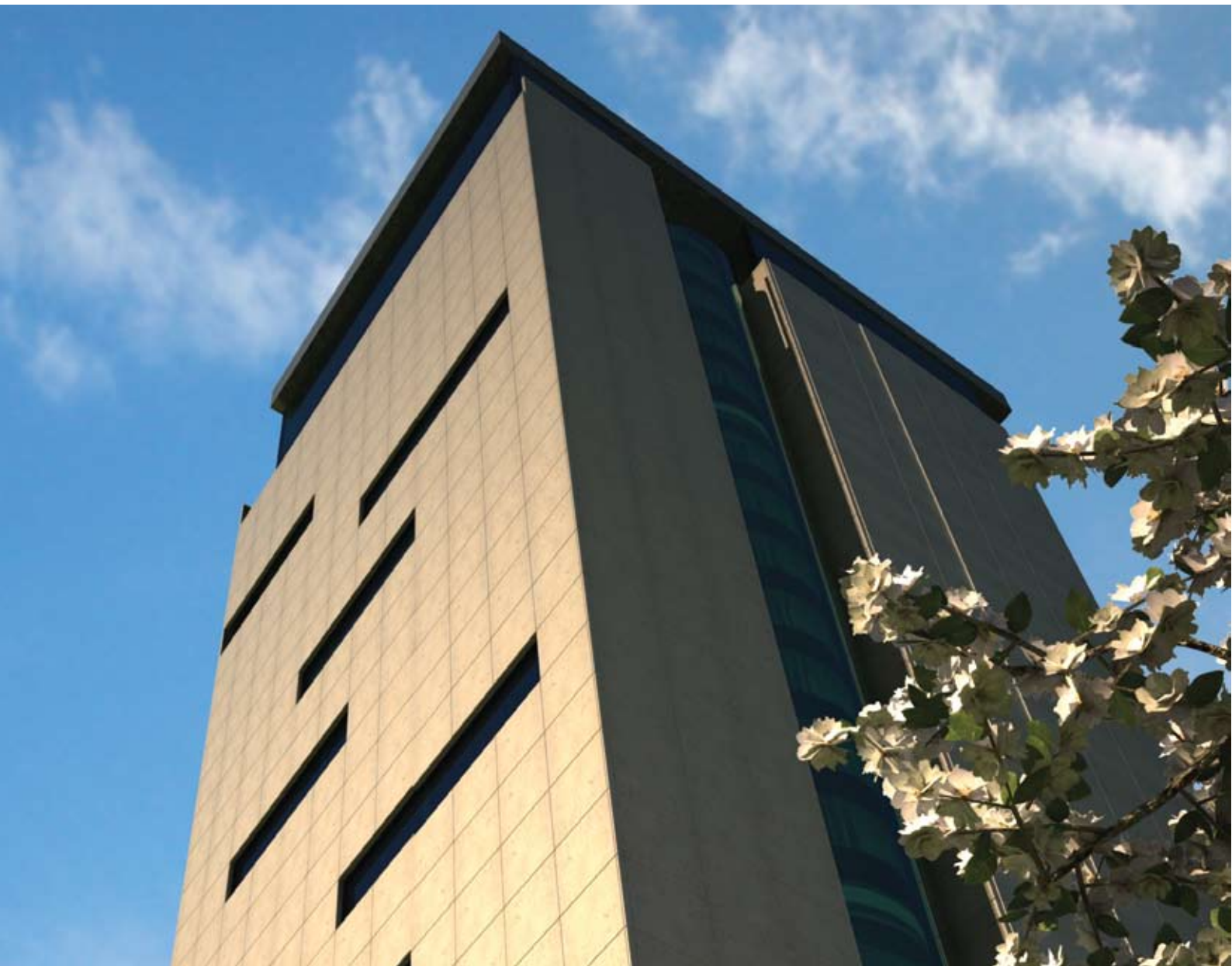
Particular attention shall be dedicated to the phenomenon of galvanic corrosion, which comes about whenever a more noble metal is placed into direct contact with another metal in the presence of an electrolyte (water containing salts, acids or substances deriving from combustion).

Under such conditions, a chemical reaction takes place which tends to damage the less noble metal.

Galvanic corrosion is particularly dangerous whenever the mass of the noble metal is inferior to that of the more noble metal. The ratio between these two masses, the direct-contact surface area, and the difference in potential between the two metals, determine the degree of corrosion or deterioration.

For this reason, the material most commonly-advised for the realization of a complete set of fixings is Stainless steel AISI 304 which, in addition to guaranteeing optimum mechanical resistance features, is suited to satisfactory resistance.

Several combinations of different metals may be acceptable, provided that the designer is aware of the specific environmental conditions, and that the combination is compatible with the same.



Corrosion protection. Assembly aids

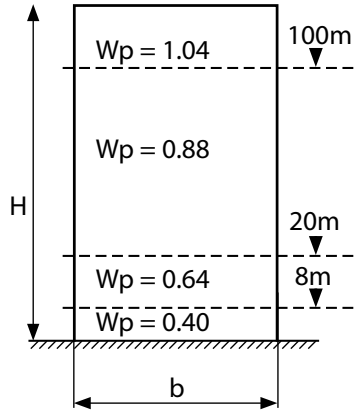
Material Observed for contact corrosion	Area Ratio to	Stainless Steel	Copper	Tin	Lead	Chrome Steel	Cast Steel	Low alloy steel	Construction Steel	Acid zinc coating	Aluminum alloy	Hot galvanized steel	Zinc	Magnesium alloy
Stainless Steel	Small			+	+		+	+		+	+	+	+	+
	Large		+	o	o	o	+	+	+	+	+	o	+	+
Copper	Small			-	o	o		+	+	+	+	+	+	+
	Large	+		o	+		+	+	+	+	+	+	+	+
Tin	Small				+	+		+	+	+	+	+	+	+
	Large				+	o	+	+	+	+	+	+	+	+
Lead	Small		+	+		+	+	+	+	+	+	+	+	+
	Large	+		+		+	o	+	+	+	+	+	+	+
Chrome Steel	Small	-	-	o	o			+	+	+	+	+	+	+
	Large	+		+	+			+	+	+	+	+	+	+
Cast Steel	Small	-	-	-	-	-		o	+	+	+	+	+	+
	Large			+	+	+		+	+	+	+	+	+	+
Low Alloy Steel	Small	-	-	-	-	-	+		o	+	+	+	+	+
	Large	+	+	+	+	+	+		+	+	+	+	+	+
Construction Steel	Small	-	-	-	-	-	-	o		+	+	+	+	+
	Large	+	+	+	+	+	+	+		+	+	+	+	+
Acid Zinc Coating	Small	-	-	-	-	-	-	-	-		+	+	+	+
	Large	+	+	+	+	+	+	+	+		+	o	+	o
Aluminum Alloy	Small	-	-		-		-		o	+		+	+	o
	Large	o	-	-	-	o	o	+	+	+		o	o	+
Hot Galvanized Steel	Small	-	-	-	-	-	-	-	-	o	o		+	o
	Large	+	+	+	+	+	+	+	+	+	+		+	+
Zinc	Small	-	-	-	-	-	-	-	-	o	o	+		o
	Large	+	+	+	+	+	+	+	+	+	+	+		+
Magnesium Alloy	Small	-	-	-	-	-	-	-	-	-	-	-	-	
	Large	-	-	-	-	-	-	-	-	o	o	o	o	

Relation of the surface of the material observed (column) to the surface of the second material (line)
– = heavy corrosion of the material observed
o = moderate corrosion of the material observed
+ = slight or no corrosion of the material observed

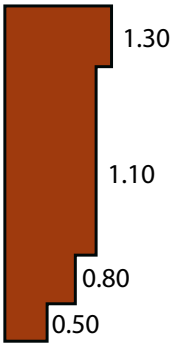
TYPES OF LOADS

Wind Load for Cladding Facade According to DIN 1055, Part 4

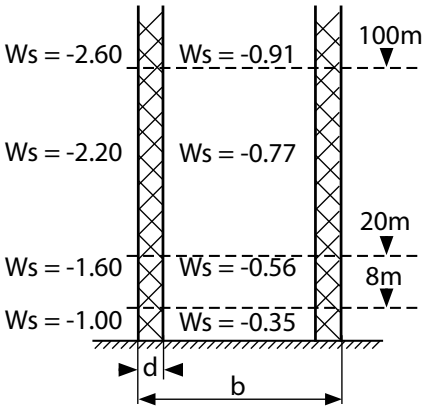
Wind pressure
Wp (kN/m²)



Velocity pressure
q(kN/m²)



Wind suction
Ws (kN/m²)



Wind pressure= Wp = C_p x q (kN/m²)
C_p = aerodynamic pressure coefficient

A = building length
b = building width
H = height of building
q = velocity pressure
d = length of the corner
Wp = wind pressure
Ws = wind suction

Wind Suction in corner d

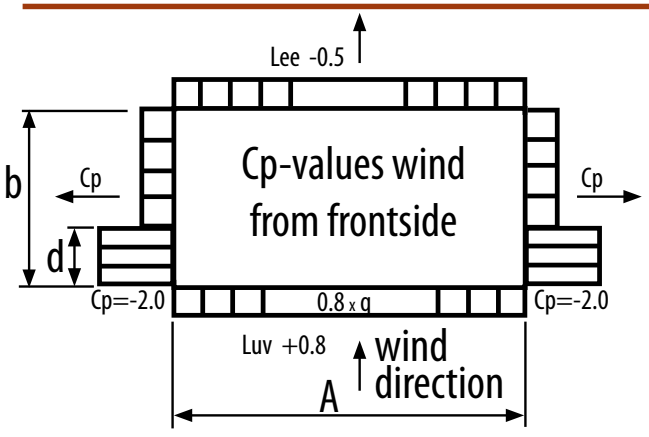
Height	0 - 8 m	> 8 m - 20 m	> 20 m - 100 m	> 100 m
WS KN/m²	-1,00 (-2 x 0,50)	-1,60 (-2 x 0,80)	-2,20 (-2 x 1,10)	-2,60 (-2 x 1,30)

wind Pressure

Height	0 - 8 m	> 8 m - 20 m	> 20 m - 100 m	> 100 m
Wp KN/m²	0,4	0,6	0,88	1,04

wind Suction in Surface

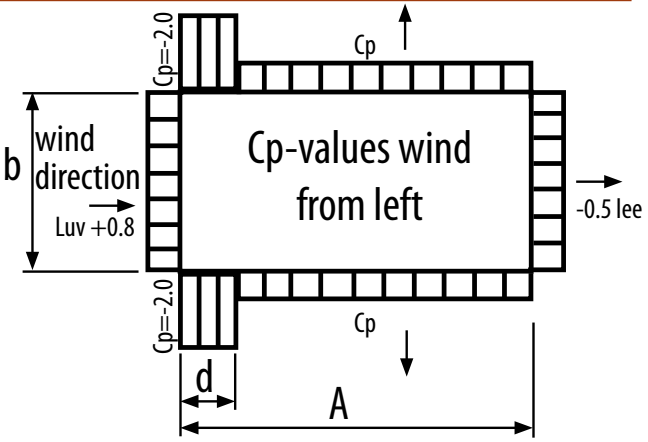
Height	0 - 8 m	> 8 m - 20 m	> 20 m - 100 m	> 100 m
Ws KN/m²	-0,35	-0,56	-0,77	-0,91



Wind Suction = C_p x q

Wind suction coefficient C_p on corner	Corner length d
-2.0	For b < 8m , d=1m 8m ≤b ≤ 16m , d=A/8 For b> 16m , d= 2m

C_p = Aerodynamic Coefficient
-0.7 for H/b > 0.5
-0.5 for H/b < 0.25
Values in between can be obtained by interpolation.
H = Building height
A= Building length
b= Building width



Wind Suction = Cp x q

Wind suction coefficient C_p on corner	Corner length d
-2.0	For A < 8m , d=1m 8m ≤A ≤ 16m , d=A/8 For A> 16m , d= 2m

C_p =
-0.7 for H/A > 0.5
-0.5 for H/A < 0.25
Values in between can be obtained by interpolation.

Minus sign, means suction
Plus sign, means pressure

WIND LOAD ACCORDING TO DIN 1055

1.1 Wind Force

The total wind force which acts on a structure or component
$W_l = C_p \times q_{(ze)} \times A$
C_p = Aerodynamic Coefficient
q_{ze} = Velocity pressure at the reference height
A = Reference area

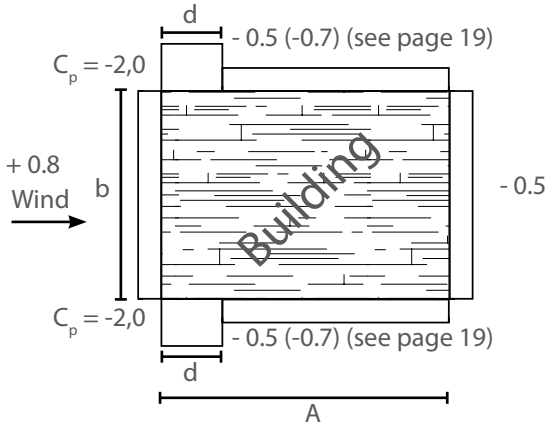
- Wind Velocity and Wind Velocity Pressure

Height	0-8 m	>8 m - 20 m	>20 m - 100 m	>100 m
Wind Velocity m/s	28,3	35,80	42,00	45,6
velocity pressure q kN/m²	0,50	0,8	1,10	1,30

Wind Suction
$W_s = C_p \times q$
C_p = Aerodynamic Coefficient
q = Velocity Pressure

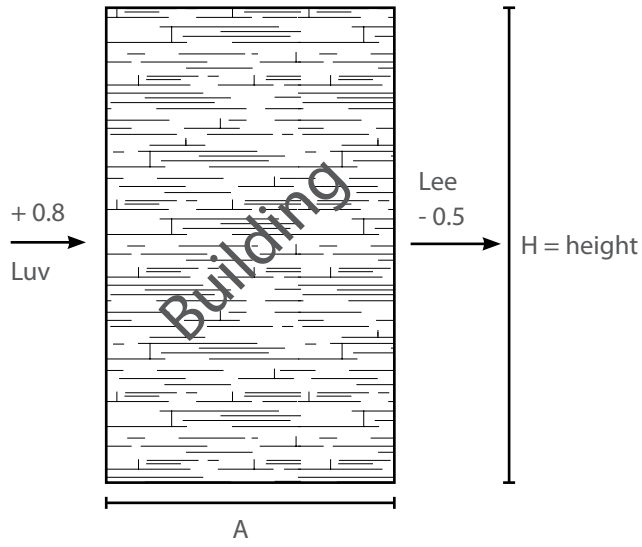
- Suction Coefficient in area of discontinuity

Increasing Coefficient C_p	A (m)	Width of d (m)
-2,0	A<8 m	1,0 m
	8 m < A <16 m	A/8
	A > 16,0 m	2,0 m

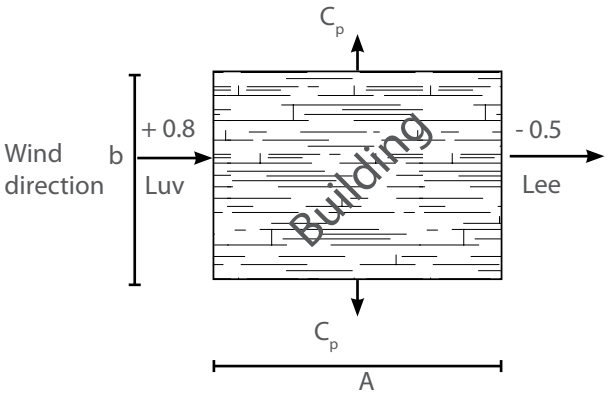


Wind Pressure = W = C_p x q (kN/m²)

Aerodynamic Pressure Factor C_p
Elevation Section



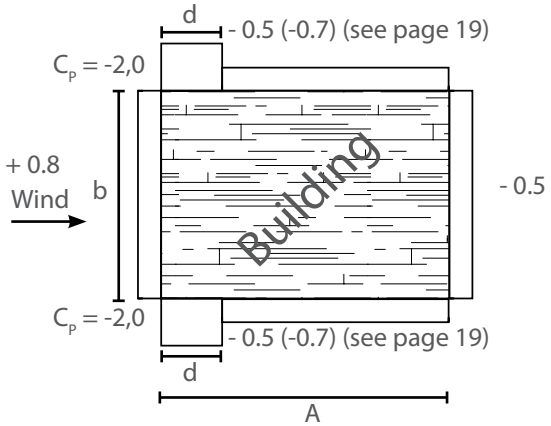
Plan Section



Pressure coefficient C_p on lateral walls with width W
C_p = -0,5 for H/A ≤ 0,25
C_p = -0,7 for H/A > 0,5

b = building width
A = building length
H = building height

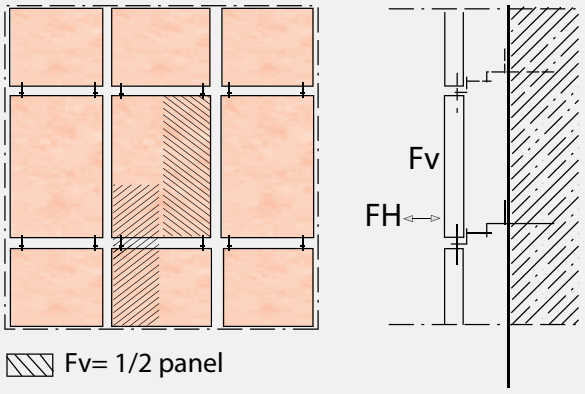
Wind pressure on corners
d = Length of corner



C_p = -2,0 = Pressure coefficient on corner
d = 1m for A < 8 m
d = A/8 for 8m < A < 16 m
d = 2,0 m for A > 16 m

WIND LOAD ACCORDING TO DIN 1055

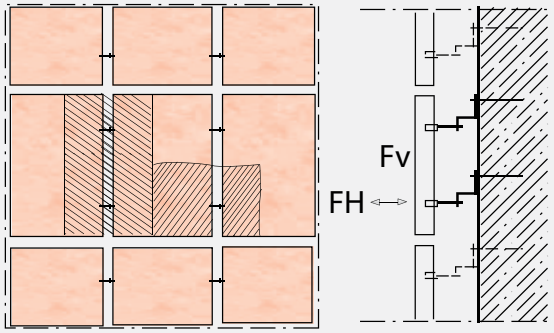
Horizontal joints



Fv= 1/2 panel

FH= 1/2 panel

Vertical joints



Fv= 1 panel

FH= 1/2 panel

Loads For Support Anchor

Characteristic weights of natural stone panels [kN/m²]

Density kN/m³	Plate thickness [cm]					
	2,0	3,0	4,0	5,0	6,0	7,5
20	0,40	0,60	0,80	1,00	1,20	1,50
24	0,48	0,72	0,96	1,20	1,44	1,80
25	0,50	0,75	1,00	1,25	1,50	1,88
26	0,52	0,78	1,04	1,30	1,56	1,95
27	0,54	0,81	1,08	1,35	1,62	2,03
28	0,56	0,84	1,12	1,40	1,68	2,10
30	0,60	0,90	1,20	1,50	1,80	2,25

Characteristic loads per panel [kN] by panel thickness 3cm and stone density 26kN/m³ (0,78kN/m²)

Self weight kN	Size m²	Wind pressure FH kN			Wind suction FH (A) kN			Wind suction FH (B) kN		
		0-8m	8-20m	20-100m	0-8m	8-20m	20-100m	0-8m	8-20m	20-100m
0,3	0,38	0,15	0,25	0,34	-0,38	-0,62	-0,85	-0,13	-0,22	-0,30
0,6	0,77	0,31	0,49	0,68	-0,77	-1,23	-1,69	-0,27	-0,43	-0,59
0,9	1,15	0,46	0,74	1,02	-1,15	-1,85	-2,54	-0,40	-0,65	-0,89
1,2	1,54	0,62	0,98	1,35	-1,54	-2,46	-3,38	-0,54	-0,86	-1,18
1,5	1,92	0,77	1,23	1,69	-1,92	-3,08	-4,23	-0,67	-1,08	-1,48
1,8	2,31	0,92	1,48	2,03	-2,31	-3,69	-5,08	-0,81	-1,29	-1,78

Characteristic loads per panel [kN] by panel thickness 4cm and stone density 28kN/m³ (1,12kN/m²)

Self weight kN	Size m²	Wind pressure FH kN			Wind suction FH (A) kN			Wind suction FH (B) kN		
		0-8m	8-20m	20-100m	0-8m	8-20m	20-100m	0-8m	8-20m	20-100m
0,4	0,36	0,14	0,23	0,31	-0,36	-0,57	-0,79	-0,13	-0,20	-0,28
0,8	0,71	0,29	0,46	0,63	-0,71	-1,14	-1,57	-0,25	-0,40	-0,55
1,2	1,07	0,43	0,69	0,94	-1,07	-1,71	-2,36	-0,38	-0,60	-0,83
1,6	1,43	0,57	0,91	1,26	-1,43	-2,29	-3,14	-0,50	-0,80	-1,10
2,0	1,79	0,71	1,14	1,57	-1,79	-2,86	-3,93	-0,63	-1,00	-1,38
2,4	2,14	0,86	1,37	1,89	-2,14	-3,43	-4,71	-0,75	-1,20	-1,65

SEISMIC LOAD ACCORDING TO UBC (UNIFORM BUILDING CODE)

Seismic Load

Seismic loading is one of the basic concepts of earthquake engineering which means implication of an earthquake generated agitation to a structure. It happens at the contact surface of a structure, either with the ground or with an adjacent structure:

$$SL = \frac{(2.5 \times Ca \times I)}{R} D \qquad SL \geq 0.11\ Ca \times I \times D$$

SL = Seismic load, Ca = Seismic response spectrum = Lateral force value in 97 UBC table 16-Q
I = Importance factor given in 97 UBC Table 16 K
R = Component response modification factor from 97 UBC Table 16N
D = Dead Load

It is common practice to express the Seismic load as a percentage of dead load, calculating only the coefficient term.

Zone	Seismic Load
1	0.06 7x D
2a	0.122 x D
2b	0,156 x D
3	0.2 x D
4	0.244 x D

Seismic Zone

Zone	Damage to Structure
0	No Damage
1	Minor
2	Moderate
3	Major
4	Huge

Table 16-K - OCCUPANCY CATEGORY

Occupancy Category	Occupancy or functions of Structure	Seismic Importance Factor, *I*	Seismic Importance Factor[1], I_p	Seismic Importance Factor, I_w
1. Essential facilities[2]	Group I, Division 1 Occupancies having surgery and emergency treatment areas Fire and police stations Garages and shelters for emergency vehicles and emergency aircraft Structures and shelters in emergency - preparedness centers Aviation control towers Structures and equipment in government communication centers and other facilities required for emergency response Standby power - generating equipment for Category 1 facilities Tanks or other structures containing housing or supporting water or other fire - suppression material or equipment required for the protection of ategory 1.2 or 3 structures.	1.25	1.50	1.15
2. Hazardous facilities	Group H, Divisions 1, 2, 6 and 7 Occupancies and structures therein housing or supporting toxic or explosive chemicals or substances Non building structures housing, supporting or containing quantities for toxic or explosive substances that, if contained within a building, would cause that building to be classified as a Group H, Division 1, 2 or 7 Occupancy	1.25	1.50	1.15
3. Special occupancy structures[3]	Group A, Divisions 1, 2 and 2.1 Occupancies Buildings housing Group E, Divisions 1 and 3 occupancies with a capacity greater than 300 students Buildings Housing Group B Occupancies used for college or adult education with a capacity greater than 500 students Group I, Divisions 1 and 2 Occupancies with 50 or more resident incapacitated patients, but not included in Category I Group I, Division 3 Occupancies All structures with an occupancy greater than 5.000 persons Structures and equipment in power-generating stations, and other public utility facilities not included in Category 1 or Category 2 above, and required for continued operation	1.00	1.00	1.00
4. Standard occupancy structures[3]	All structures housing occupancies or having functions not listed in Category 1, 2 or 3 and Group U Occupancy towers	1.00	1.00	1.00
5. Miscellaneous structure	Group U Occupancies except for towers	1.00	1.00	1.00

SEISMIC LOAD ACCORDING TO UBC

TABLE 16-N-STRUCTURAL SYSTEMS[1]

BASIC STRUCTURAL SYSTEM2	LATERAL-FORCE-RESISTING SYSTEM DESCRIPTION	R	O	HEIGHT LIMIT FOR SEISMIC ZONES 3 AND 4 (feet) x 304.8 for cm
1. Bearing wall system	1. Light-framed walls with shear panels			
	a. Wood structural panel walls for structures three stories or less	5.5	2.8	65
	b. All other light-framed walls	4.5	2.8	65
	2. Shear walls			
	a. Concrete	4.5	2.8	160
	b. Masonry	4.5	2.8	160
	3. Light steel-framed bearing walls with tension-only bracing	2.8	2.2	65
	4. Braced frames where bracing carries gravity load			
	a. Steel	4.4	2.2	160
	b. Concrete[3]	2.8	2.2	-
	c. Heavy timber	2.8	2.2	65
2. Building frame system	1. Steel eccentrically braced frame (EBF)	7.0	2.8	240t
	2. Light-framed walls with shear panels			
	a. Wood structural panel walls for structures three stories or less	6.5	2.8	65
	b. All other light-framed walls	5.0	2.8	65
	3. Shear walls			
	a. Concrete	5.5	2.8	240
	b. Masonry	5.5	2.8	160
	4. Ordinary braced frames			
	a. Steel	5.6	2.2	160
	b. Concrete 3	5.6	2.2	--
	c. Heavy timber	5.6	2.2	65
	5. Special concentrically braced frames			
	a. Steel	6.4	2.2	240
3. Moment-resisting frame system	1. Special moment-resisting frame (SMRF)			
	a. Steel	8.5	2.8	N.L.
	b. Concrete[4]	8.5	2.8	N.L.
	2. Masonry moment-resisting wall frame (MMRWF)	6.5	2.8	160
	3. Concrete intermediate moment-resisting frame (IMRF)[5]	5.5	2.8	--
	4. Ordinary moment-resisting frame (OMRF)			
	a. Steel[6]	4.5	2.8	160
	b. Concrete[7]	3.5	2.8	--
	5. Special truss moment frames of steel (STMF)	6.5	2.8	240
4. Dual systems	1. Shear walls			
	a. Concrete with SMRF	8.5	2.8	N.L.
	b. Concrete with steel OMRF	4.2	2.8	160
	c. Concrete with concrete IMRF[5]	6.5	2.8	160
	d. Masonry with SMRF	5.5	2.8	160
	e. Masonry with steel OMRF	4.2	2.8	160
	f. Masonry with concrete IMRF[3]	4.2	2.8	--
	g. Masonry with masonry MMRWF	6.0	2.8	160
	2. Steel EBF			
	a. With steel SMRF	8.5	2.8	N.L.
	b. With steel OMRF	4.2	2.8	160
	3. Ordinary braced frames			
	a. Steel with steel SMRF	6.5	2.8	N.L.
	b. Steel with steel OMRF	4.2	2.8	160
	c. Concrete with concrete SMRF[3]	6.5	2.8	--
	d. Concrete with concrete 1MRF[3]	4.2	2.8	--
	4. Special concentrically braced frames	7.5	2.0	N.L.
	a. Steel with steel SMRF	4.2	2.8	160
	b. Steel with steel OMRF			
5. Cantilevered column building systems	1. Cantilevered column elements	2.5	2.0	35[7]
6. Shear \wall-frame interaction systems	1. Concrete[8]	5.5	2.8	160
7. Undefined systems	See Sections 1629.6.7 and 1629.9.2	--	--	--

N.L.-no limit
[1]Sec Section 1630.4 for combination of structural systems.
[2]Basic structural systems are defined in Section 1629.6.
[3]Prohibited in Seismic Zones 3 and 4.
[4]Includes precast concrete conforming to Section 1921.2.7.
[5]Prohibited in Seismic Zones 3 and 4, except as permitted in Section 1634.2.
[6]Ordinary moment-resisting frames in Seismic Zone 1 meeting the requirements of Section 2211.6 may use a R value of 8.
[7]Total height of the building including cantilevered columns.
[8]Prohibited in Seismic Zones 2A, 2B, 3 and 4. See Section 1633.2.7.

TABLE 16-0-HORIZONTAL FORCE FACTORS, ap AND R_p

ELEMENTS OF STRUCTURES AND NON STRUCTURAL COMPONENTS AND EQUIPMENT[1]	*ap*	R_p	FOOTNOTE
1. Elements of Structures A. Walls including the following: (1) Unbraced (cantilevered) parapets.	2.5	3.0	
(2) Exterior walls at or above the ground floor and parapets braced above their centers of gravity	1.0	3.0	2
(3) All interior-bearing and non bearing walls.	1.0	3.0	2
B. Penthouse (except when framed by an extension of the structural frame).	1.5	4.0	
C. Connections for prefabricated structural elements other than walls. See also Section 1632.2.	1.0	3.0	3
2. Non structural Components A. Exterior and interior amentations and appendages.	2.5	3.0	
B. Chimneys, stacks and trussed towers supported on or projecting above the roof: (l) Laterally braced or anchored to the structural frame at a point below their centers of mass.	2.5	3.0	
(2) Laterally braced or anchored to the structural frame at or above their centers of mass	1.0	3.0	
C. Signs and billboards.	2.5	3.0	
D. Storage racks (include contents) over 6 feet (1829 mm) tall	2.5	4.0	
E. Permanent floor-supported cabinets and book stacks more than 6 feet (1829 mm) in height (include contents).	1.0	3.0	
F. Anchorage and lateral bracing for suspended ceilings and light fixtures.	1.0	3.0	3,6,7,8
G. Access floor systems.	1.0	3.0	4,5,9
H. Masonry or concrete fences over 6 feet (1829 mm) high.	1.0	3.0	
I. Partitions.			
3. Equipment A. Tanks and vessels (include contents), including support systems.	1.0	3.0	
B. Electrical, mechanical, plumbing equipment, associated conduit, ductwork and piping.	1.0	3.0	5,10,11,12,13,14,15,16
C. Any flexible equipment laterally braced or anchored to the structural frame at a point below their center of mass.	2.5	3.0	5,10,14,15,16
D. Anchorage of emergency power supply systems and essential communications equipment. Anchorage and support systems for battery racks and fuel tanks necessary for operation of emergency equipment. See also Section 1632.2.	1.0	3.0	17,18
E. Temporary containers with flammable or hazardous materials.	1.0	3.0	19
4. Other Components A. Rigid components with ductile material and attachments.	1.0	3.0	1
B. Rigid components with non ductile material or attachments.	1.0	1.5	1
C. Flexible components with ductile material and attachments.	2.5	3.0	1
D. Flexible components with non ductile material or attachments.	2.5	1.5	1

[1]See Section 1627 for definitions of flexible components and rigid components.
[2]See Sections 1633.2.4 and 1633.2.8 for concrete and masonry walls and Section 1632.2 for connections for panel connectors for panels.
[3]Applies to Seismic Zones 2,3 and 4 only.
[4]Ground supported steel storage racks may be designed using the provisions of Section 1634. Chapter 22, Division VI, may be used for design, provided seismic design forces are equal to or greater than those specified in Section 1632.2 or 1634.2, as appropriate.
[5]Only attachments, anchorage or restraints need be designed.
[6]Ceiling weight shall include all light fixtures and other equipment or partitions that are laterally supported by the ceiling. For purposes of determining the seismic force, a ceiling weight of not less than 4 psf (0.19 kN/m^2) shall be used.
[7]Ceilings constructed of lath and plaster or gypsum board screw or nail attached to suspended members that support a ceiling at one level extending from wall to wall need not be analyzed, provided the walls are not over 50 feet (15 240mm) apart.
[8]Light fixtures and mechanical services installed in metal suspension systems for acoustical title and lay-in panel ceilings shall be independently supported from the structure above as specified in UBC Standard 25-2, part III.

SEISMIC LOAD ACCORDING TO UBC

[9] W^p for access floor systems shall be the dead load of the access floor system plus 25 percent of the floor live load plus a 10-psf (0.48 kN/m^2) partition load allowance.

[10] Equipment includes, but is not limited to, boilers, chillers, heat exchangers, pumps, air-handling units, cooling towers, control panels, motors, switch gear, transformers and life-safety equipment. It shall include major conduit, ducting and piping, which services such machinery and equipment and fire sprinkler systems. See section 163.2.2 for additional requirements for determining up for non rigid or flexibly mounted equipment.

[11] Seismic restraints may be omitted from piping and duct support if all the following conditions are satisfied:

[11.1] Lateral motion of the piping or duct will not cause damaging impact with other systems.

[11.2] The piping or duct is made of ductile material with ductile connections.

[11.3] Lateral motion of the piping or duct does not cause impact of fragile appurtenances (e.g., sprinkler heads) with any other equipment, piping or structural member.

[11.4] Lateral motion of the piping or duct does not cause loss of system vertical support.

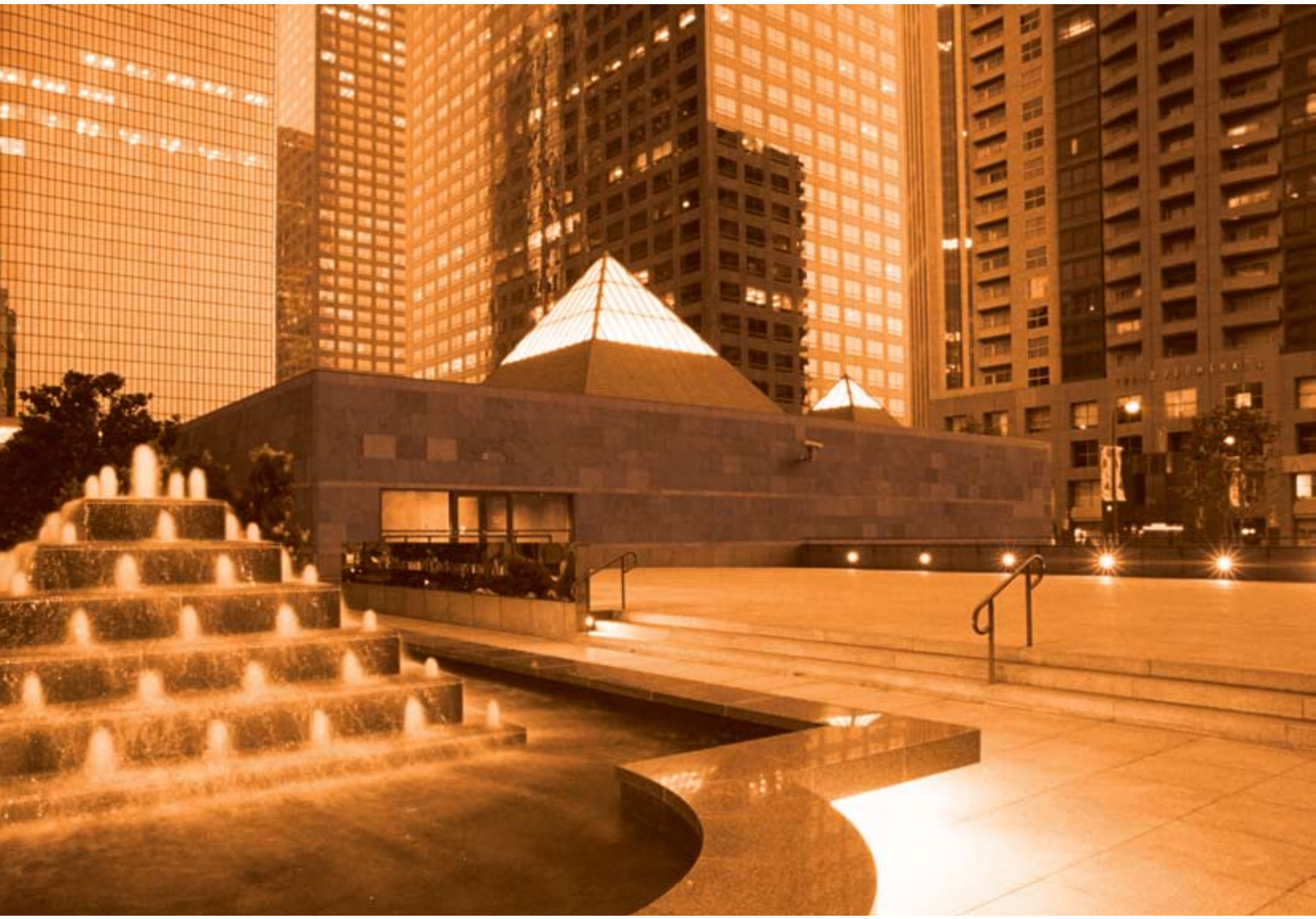
[11.5] Rod-hung supports of less than 12 inches (305mm) in length have top connections that cannot develop moments.

[11.6] Support members cantilevered up from the floor are checked for stability.

TABLE 16-Q-SEISMIC COEFFICIENT C_a

SOIL PROFILE TYPE	SEISMIC ZONE FACTOR				
	Z= 0.075	Z= 0.15	Z= 0.2	Z= 0.3	Z= 0.4
S_A	0.06	0.12	0.16	0.24	$0.32N_a$
S_B	0.08	0.15	0.20	0.30	$0.40N_a$
S_C	0.09	0.18	0.24	0.33	$0.40N_a$
S_D	0.12	0.22	0.28	0.36	$0.44N_a$
S_E	0.19	0.30	0.34	0.36	$0.36N_a$
S_F	See Footnote 1				

[1] Site-specific geotechnical investigation and dynamic site response analysis shall be performed to determine seismic coefficients tor Soil Profile Type S_F



Thermal movements

General

It is essential to take thermal movements into account. These are the relative changes in length and height due to temperature differences between the cladding, and the structure to which the cladding is fixed. The magnitude of the movements is dependent on whether the frame is entirely or partly inside the building envelope, the ambient temperature, the coefficients of the thermal expansion of the various materials (see the table) and the temperature of the various components when the cladding is fixed.

For buildings in the KSA with modern standards of thermal insulation and air conditioning, the temperatures tabulated in table KSA may be used as a guide to the extremes likely to be experienced.

Material	Coefficient of linear expansion 10^-6/ K
Steel (and any concrete casing to steel members)	12
Concrete	
Dense gravel aggregate	10 to 14
Crushed rock (except limestone)	10 to 13
Limestone aggregate	7 to 8
Lightweight aggregate	8 to 12
Masonry	
Concrete brickwork and block work	6 to 12
Dense aggregate	6 to 12
Lightweight aggregate (autoclaved)	8 to 12
Aerated (autoclaved)	8
Calcium silicate brickwork	8 to 14
Clay or shale brickwork or blockwork	5 to 8
Natural stones	
Limestone	3 to 10
Sandstone	7 to 12
Granite	8 to 10
Slate	6 to 12
Marble	3 to 15
Quartzite	9 to 12

SFSP

THERMAL MOVEMENTS

Thermal movement

1- Example of calculation of thermal movement:

Consider a building construction type that has an enclosed concrete frame with granite cladding (1000mm x 500mm x 30mm)
On a hot summers day with the building complete and occupied, the relative movement (in mm/m) of frame to cladding is given by the equation A =1000 [(tfs-tfe) Xf-(tcs-tce)Xc]
tfs = temperature (in °C) of frame in Summer
tfe = temperature (in °C) of frame upon erection
Xf = coefficient of thermal expansion of frame
tcs = temperature (in °C) of cladding in summer
tce = temperature (in °C) of cladding upon erection
Xc = coefficient of thermal expansion of cladding using the following values:
tfs = 30°C, tfe = 40°,Xf = 13x10^-6 per °C,tcs = 80°C, ce= 10°C,Xc =(8 to 10) x 10 ^-6 per °C
If Xc = 8 x 10^-6 per °C, movement = 1000[(30-40) *13-(80-10)*8]
DL= 0,69mm/m, if Xc = 10. Dl = 0.83 mm/m in both cases , the movement shall be less than 1.0mm

2- Example of calculation of deflection
Panel size : 1000mm x 500mm x 30mm
Granite with a density of 28 kN/m^3
Deflection on the support anchor with a section of (width x height) 35mm x 4mm
Existing deflection = f = ($Fv.a^3$)/3xExI
Fv = Weight of cladding panel = 420 N
a = Cavity to pin in mm = 40mm
E= Modulus of Elasticity of bracket = 170000 N/mm^2
I = Moment of Inertia = $35x4^3/12$ = 186.70mm^4
Allowable deflection f = (420Nx40^3 mm^3) / 3x170000 N/mm^2 x186.70mm^4)
f = 0.28 mm < 1.0mm

THERMAL EXPANSION

Thermal Expansion

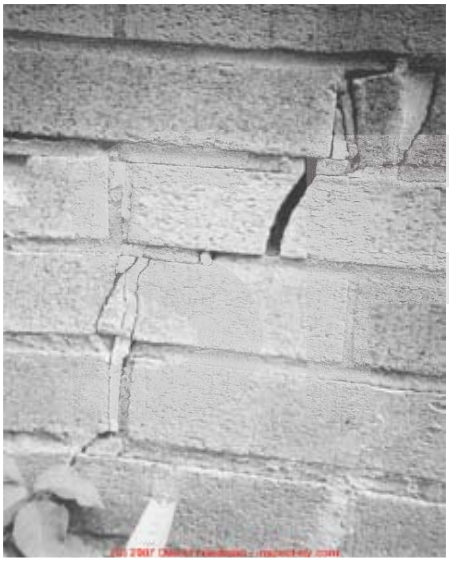
The thermal expansion of natural stone is an important consideration where natural stone is used with dissimilar materials to form large units which are rigidly fixed.
The coefficient of thermal expansion varies from one variety of natural stone to another, so the actual thermal characteristics of a specific natural stone should be obtained from the supplier when the final choice of a natural stone is made.

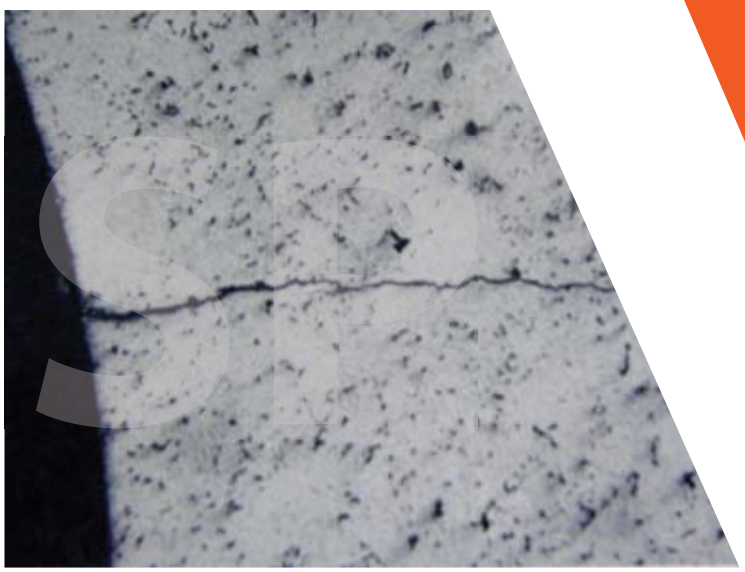
Coefficients of thermal expansion	
Material	Linear expansion ' (in/°F)
Aluminium	0.0000133
Brass	0.0000104
Bronze	0.0000101
Bronze	0.0000096
Concrete	0.0000079
Marble	0.0000073
Granite	0.0000078
Lime stone	0.0000060
Masonry	0.0000035
Mild steel	0.0000067

Thermal expansion is calculated as follows: $\Delta L = \alpha \cdot h \cdot \Delta T \sim 0.5$ mm/m

Where
- ΔL: Change in height of panel in [mm]
- α: Coefficient of thermal expansion in [mm/°C]
- h: Height of panel in [mm]
- ΔT: Change in temperature in [°C]

We need joints, allowable movement ≥ thermal expansion



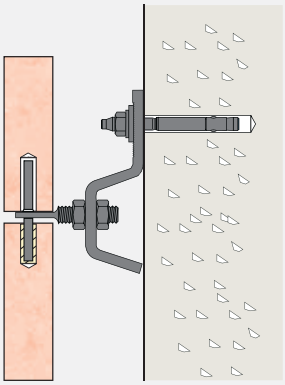


TYPES OF FIXINGS

TYPES OF FIXINGS

Principles for the Fixing of Building Cladding

The fixing systems for building cladding are composed of several elements (angles, expansion bolts, screws, nuts, washers, etc), each of which shall present the appropriate mechanical features in respect to the requirements posed by the specific project.



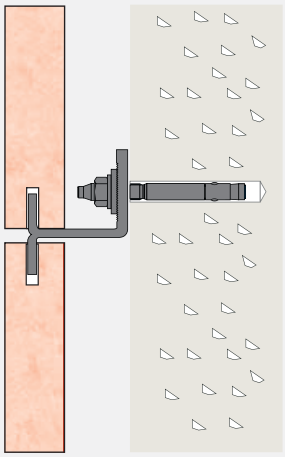
Any type of cladding, once fixed, is subject to two primary types of load:

- Permanent load (the dead load), due to the weight of the cladding itself;
- Variable load (applied loads), due to the wind, thermal expansions, seismic motions, etc.

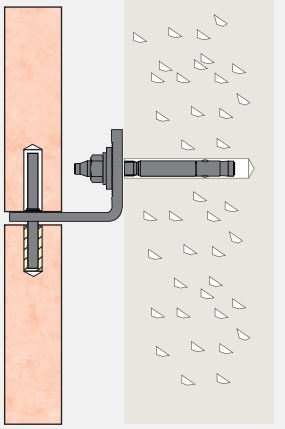
Two fundamental types of fixing systems result:

- Load-bearing fixing: to support the permanent load and the vertical components of the variable loads.
- Restraining fixing: to support the horizontal components of the loads.

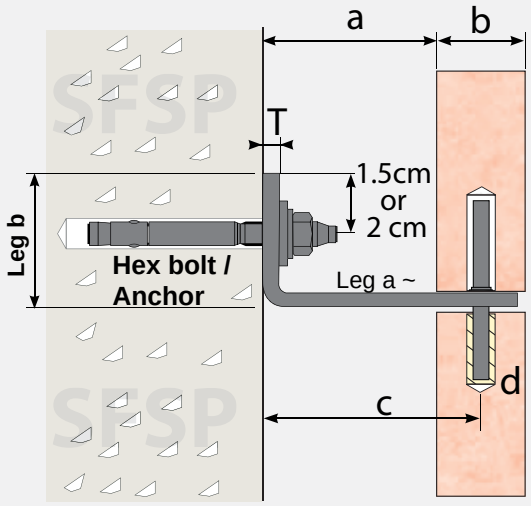
Load-bearing fixing are usually composed by angles (of adequate dimensions), firmly fixed to the building by the selected anchoring element complete with expansion anchors and bolts.



Restraining fixings instead, serve to maintain the slabs in the positions specified by the project design. Thanks to the systems of adjustment with which they are equipped, the absence of perfect verticality in the external surfaces may be easily overcome.



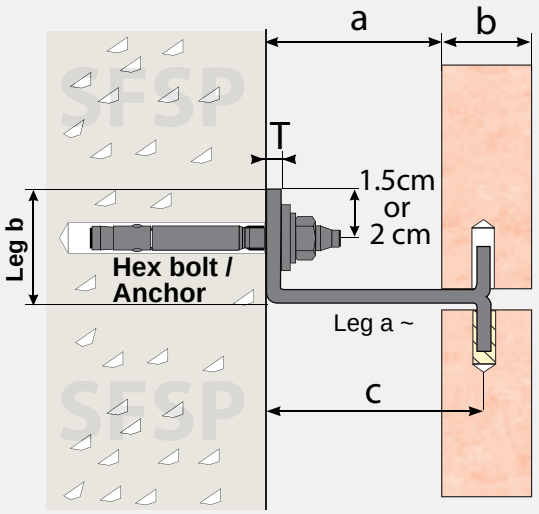
L-Bracket (Standard & Serrated) With Pin | Type ST- 500 1100



L-Bracket holder with pin.	
a	Cavity to back side panel
b	Panel thickness
T	Bracket thickness
d	Diameter of pin
c	Cavity to pin

Economic for 20 < a ≤ 80mm

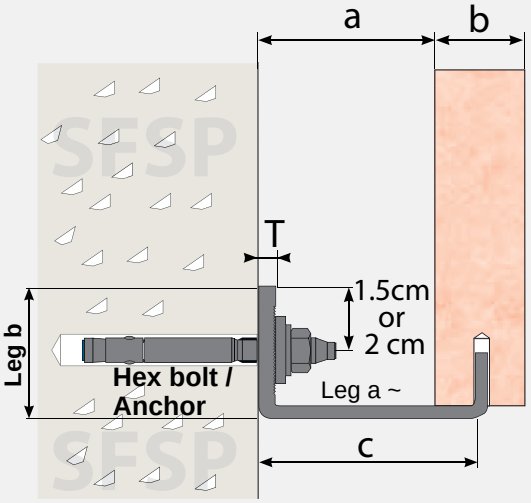
L-Bracket (Standard & Serrated) Up and Down | Type ST- 500 1200



L-Bracket holder up and down.	
a	Cavity to back side panel
b	Panel thickness
T	Bracket thickness
c	Cavity to leg

Economic for 20 < a ≤ 80mm

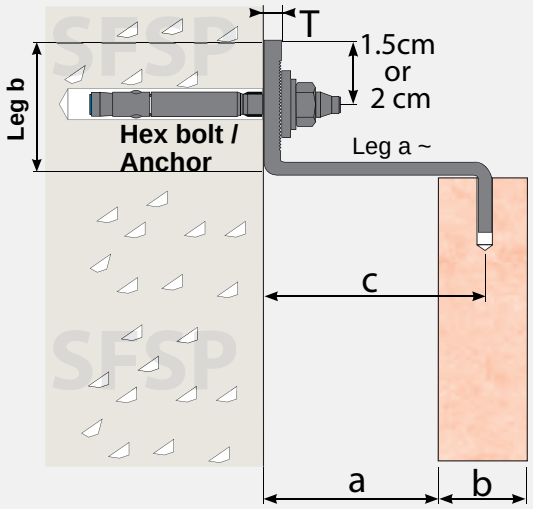
L-Bracket (Standard & Serrated) Up | Type ST- 500 1300



L-Bracket holder up .	
a	Cavity to back side panel
b	Panel thickness
T	Bracket thickness
c	Cavity to leg

Economic for 20 < a ≤ 80mm

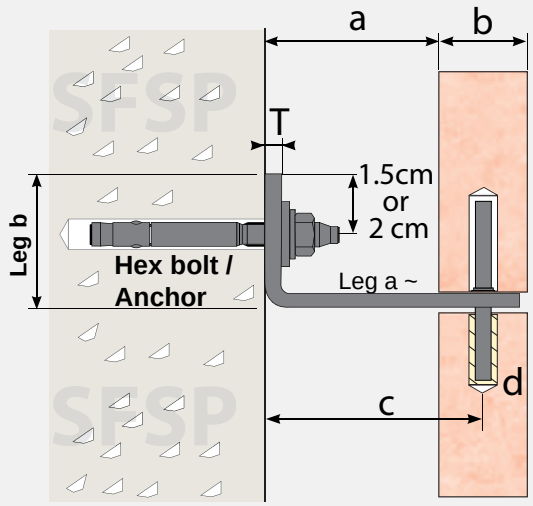
L-Bracket (Standard & Serrated) Down | Type ST- 500 1400



L-Bracket holder down.	
a	Cavity to back side panel
b	Panel thickness
T	Bracket thickness
c	Cavity to leg

Economic for 20 < a ≤ 80mm

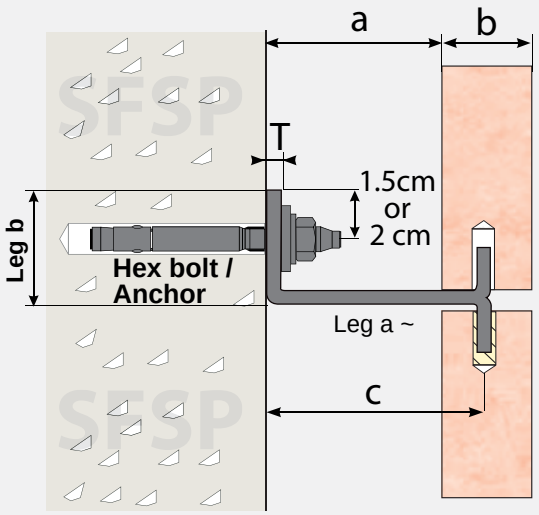
L-Bracket (Standard & Serrated) With Two Pins | Type ST- 500 1500



L-Bracket holder with pin.	
a	Cavity to back side panel
b	Panel thickness
T	Bracket thickness
d	Diameter of pin
c	Cavity to pin

Economic for 20 < a ≤ 80mm

L-Bracket (Standard & Serrated) Double Up and Down | Type ST- 500 1600

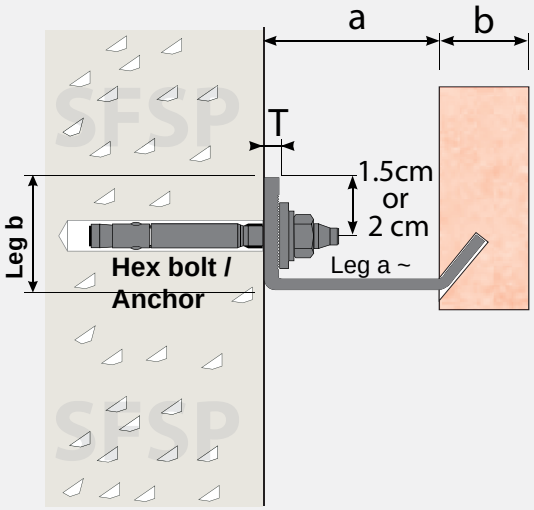


L-Bracket holder up and down.	
a	Cavity to back side panel
b	Panel thickness
T	Bracket thickness
c	Cavity to leg

Economic for 20 < a ≤ 80mm

TYPES OF FIXINGS

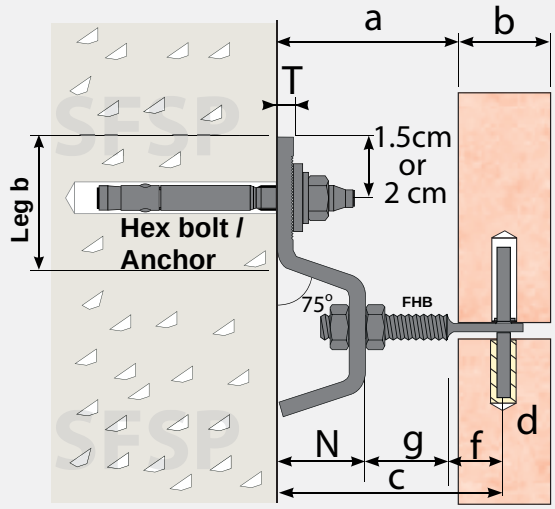
L-Bracket (Standard & Serrated) With Curved Leg | Type ST- 500 1700



L-Bracket Holder curved	
a	Cavity to back side panel
b	Panel thickness
T	Bracket thickness

Economic for 20 < a ≤ 80mm

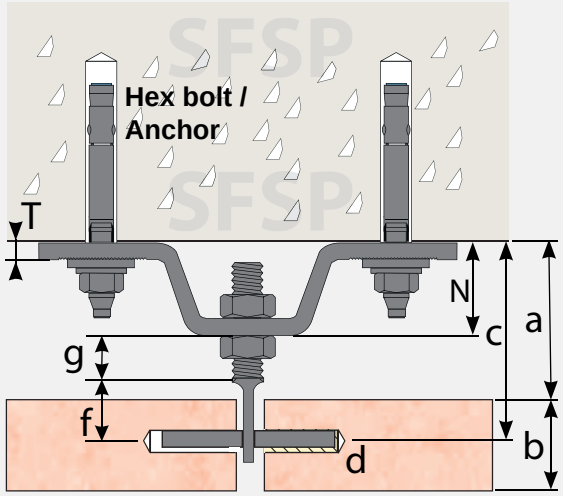
Z-Bracket with Returned Leg (Standard & Serrated) | Type ST- 600 1100



Z-returned bracket	
a	Cavity to back side panel
b	Panel thickness
T	Bracket thickness
d	Diameter of pin
c	Cavity to pin
f	Flat head parts
g	Threaded part
N	Bracket offset

Economic for 50 < a ≤ 120mm

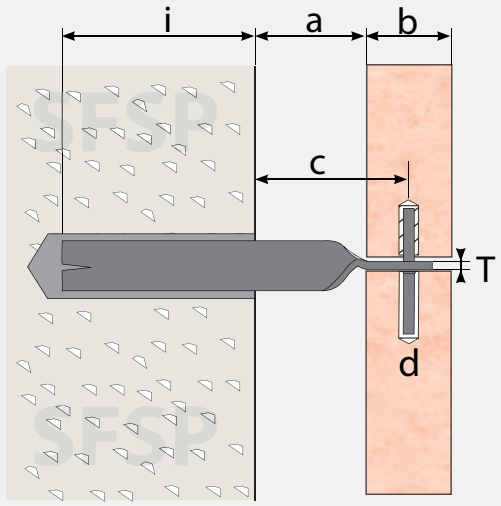
Omega Bracket (Standard & Serrated) | Type ST- 700 1100



Z-returned bracket	
a	Cavity to back side panel
b	Panel thickness
T	Bracket thickness
d	Diameter of pin
c	Cavity to pin
f	Flat head parts
g	Threaded part
N	Bracket offset

Economic for 50 < a ≤ 120mm

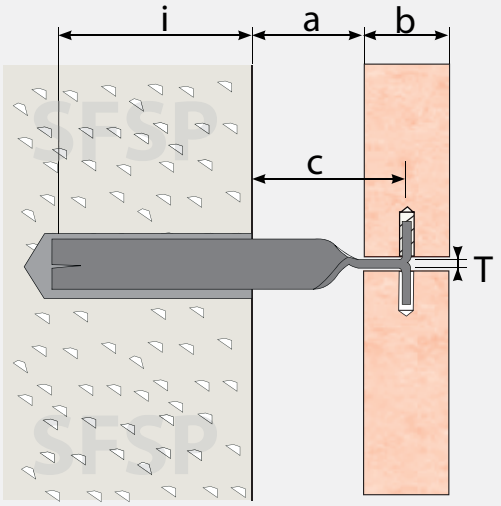
Fishtail with Pin Type ST- 800 1100



Fishtail with pin	
a	Cavity to back side panel
b	Panel thickness
d	Diameter of pin
c	Cavity to pin
i	Embedment in wall
T	Fish tail thickness

Economic for 20 < a < 80mm

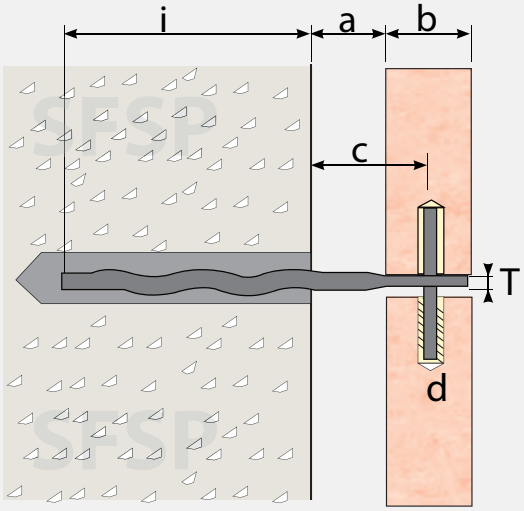
Fishtail Up & Down Type ST- 800 1200



Fishtail up & down	
a	Cavity to back side panel
b	Panel thickness
d	Diameter of pin
c	Cavity to leg
i	Embedment in wall
T	Fish tail thickness

Economic for 20 < a < 80mm

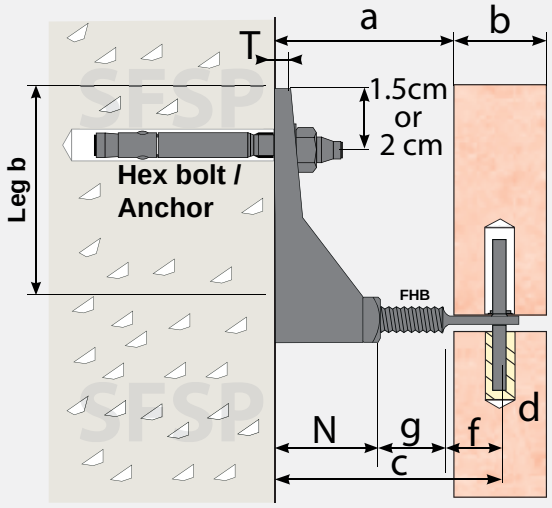
Corrugated Dowel Type ST- 900 1100



Corrugated dowel	
a	Cavity to back side panel
b	Panel thickness
d	Diameter of pin
c	Cavity to pin
i	Embedment in wall
T	Dowel thickness

Economic for 20 < a < 80mm

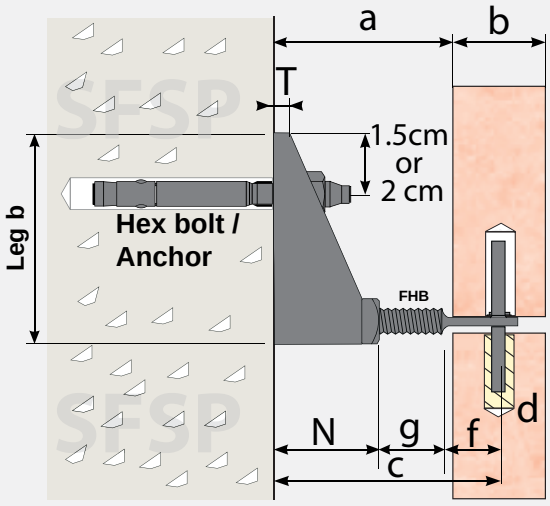
Body Bracket (Standard & Serrated) | Type ST- 1000 - 1100



Flat-Head-Bolt in C-channel	
a	Cavity to back side panel
b	Panel thickness
T	Bracket thickness
d	Diameter of pin
c	Cavity to pin
f	Flat head parts
g	Rounded part
N	Bracket offset

Economic for 50 - 100mm

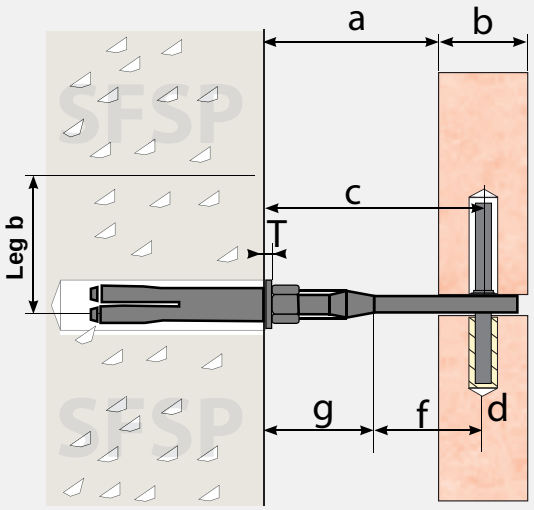
Body Bracket (Standard & Serrated) | Type ST- 1000 - 1200



Flat-Head-Bolt direct in wall	
a	Cavity to back side panel
b	Panel thickness
T	Bracket thickness
d	Diameter of pin
c	Cavity to pin
f	Flat head parts
g	Rounded part
N	Bracket offset

Economic for 80 - 135mm

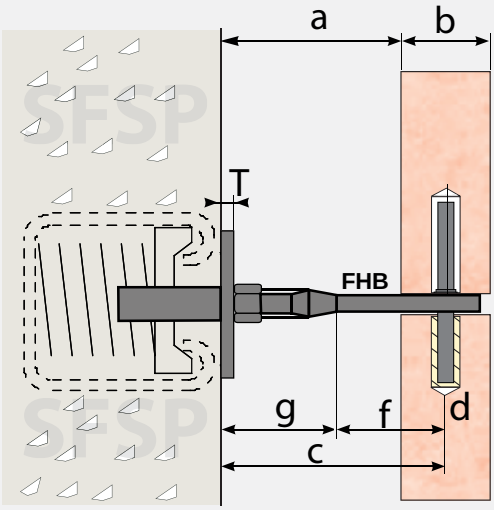
Flat-Head-Bolt Direct in Wall.



Flat-Head-Bolt direct in wall	
a	Cavity to back side panel
b	Panel thickness
T	Washer thickness
d	Diameter of pin
c	Cavity to pin
f	Flat head parts
g	Rounded part

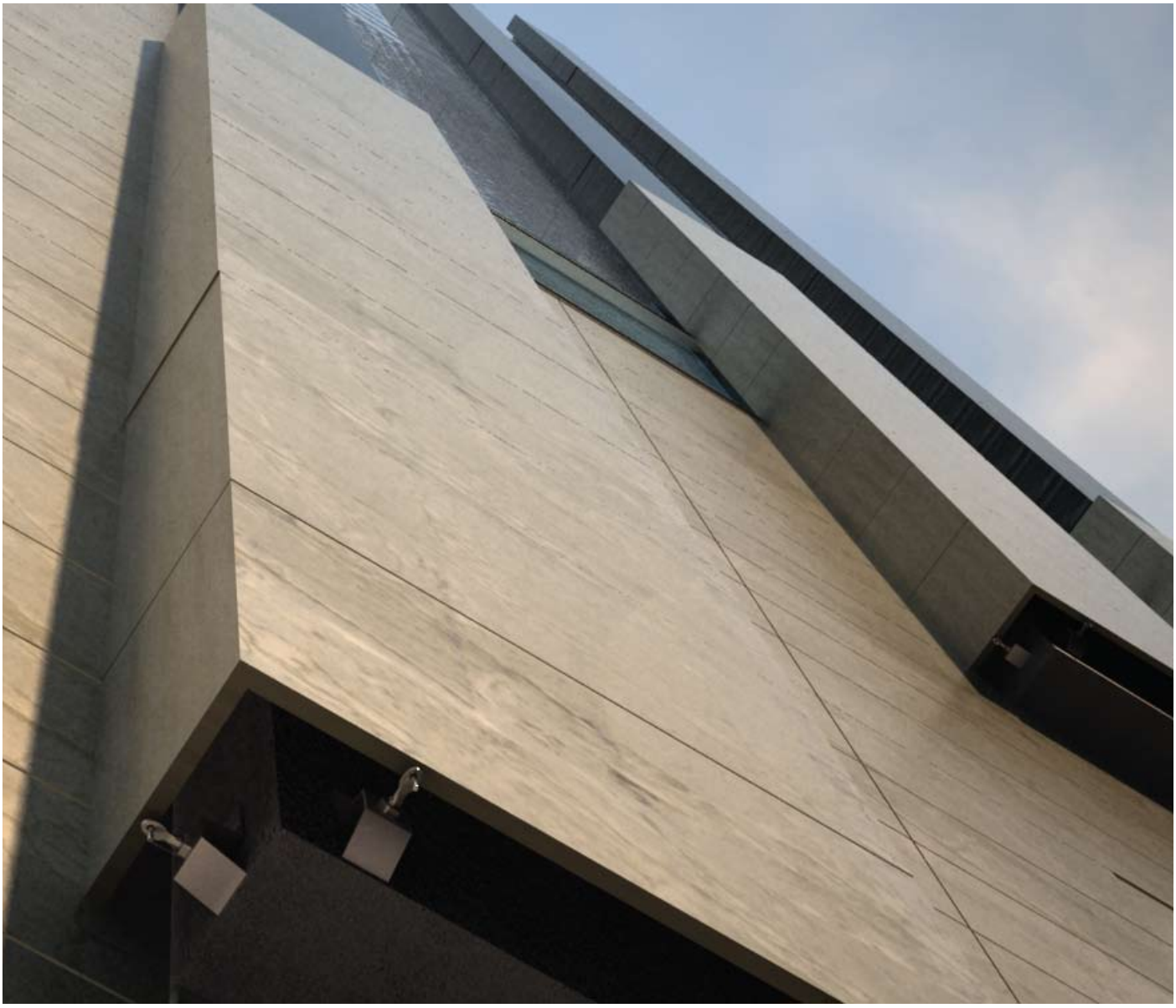
Economic for 10 < a ≤ 60mm

Flat-Head-Bolt in C-Channel.



Flat-Head-Bolt in C-channel	
a	Cavity to back side panel
b	Panel thickness
T	Plate thickness
d	Diameter of pin
c	Cavity to pin
f	Flat head parts
g	Rounded part

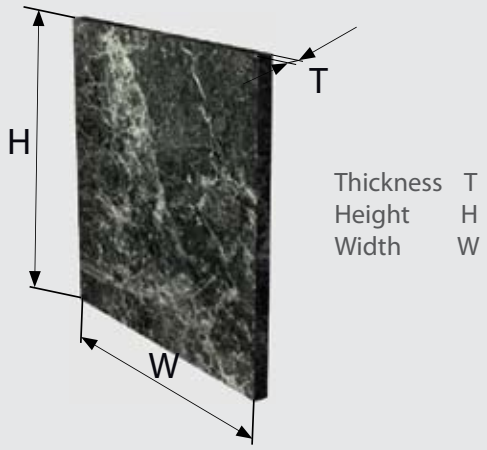
Economic for $10 < a \leq 60$mm



Design Criteria

The design for the supporting structures of buildings claddings should be based on some basic principles :
a) The type and the material of the structure to which the cladding is to be anchored (concrete, hollow brick, etc);
b) The type and the dimention to be fixed.

Cladding type	Design weight (kN/m³)
Ceramic, Tuff	20
Limestone conglomerate,	25
Nagelflue, Travertine	26
Dolomite, Sandstone, Greywake	27
Granite, Porphyry, Syenite, Slate, Limestone, Marble	28
Basalt, Diorite, Gabbro, Gneiss	30



c) The forces to which the building itself may be subject (winds of particular intensity, seismic activity, etc);
d) The environmental surroundings in which the building is located, paying particular attention to harmful atmospheric conditions which may be found in industrial, marine or other areas.
e) Arrangement of panel anchor in vertical or horizontal joints.

The awareness and a complete analysis of these factors are necessary conditions for the correct planning, in order to guarantee the highest safety levels possible.

The Dry Fixing Installation Method

The principle installation phases of a set of fixings for cladding are represented as follows:
1) Accurately locate the position of the drilling hole.
2) Drill a hole of the required depth and diameter.
3) Insert the expansion bolt into the hole and cause it to expand by screwing down the nut A.
4) To regulate the distance from the wall to the angle, rotate screw B, while keeping the nut A locked tightly in position.
If necessary, to facilitate the operation, loosen the nut A, which will be re-tightened at the end of the operation.
5) Tighten the lock-nut C for the final locking of the angle in the desired position.
6) Insert the pin in the angle to match the hole in the cladding slab.

1

2

3

4

5

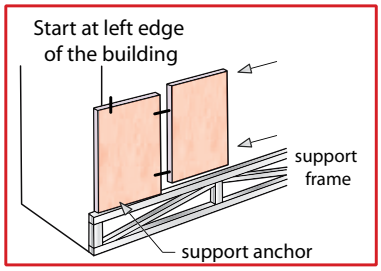
6

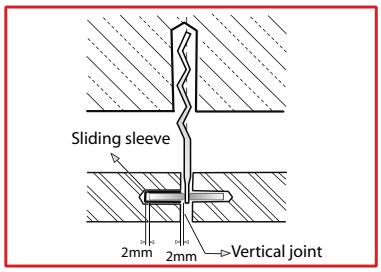
Mounting Instructions for Stangle Mortar Anchor(Wet Fixing).

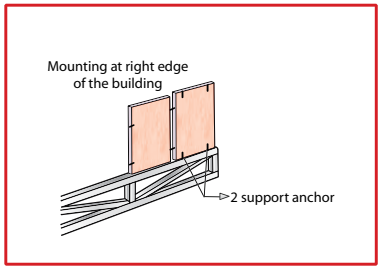
Arrangement of fixing system in vertical joint.

Take exact measurements of the building, allowing for existing tolerances. Make sufficiently large recesses in thermal insulation for natural-stone anchors. Drill out anchor-pin holes and remove drilling dust.
- Erect support frame for bottom row of panels.
- Panel mounting starts at the left edge of the building. Mount from left to right and from bottom to top.
- Place first natural-stone panel on an anchor in horizontal joint and underlay with wedge.
- Wet anchor holes and fill with cement mortar.
- Insert anchor in the two anchor holes.
- Put anchor pin through anchor and push into sliding sleeve. There shall be a clearance of about 2mm in the sleeve for the anchor pin.
Leave clear space of at least 2mm on side (sliding-sleeve side) when inserting anchor.
- Pack mortar in anchor hole and re-insert cut-out thermal insulation for exact fit.
- Fill anchor holes of second panel with mortar, and then mount second panel, etc.

Mounting at right edge of building:
- Anchor last panel but one at right edge, with pins on one side in vertical joint.
- Mount last panel at right building-edge on 2 support anchors in horizontal joint.



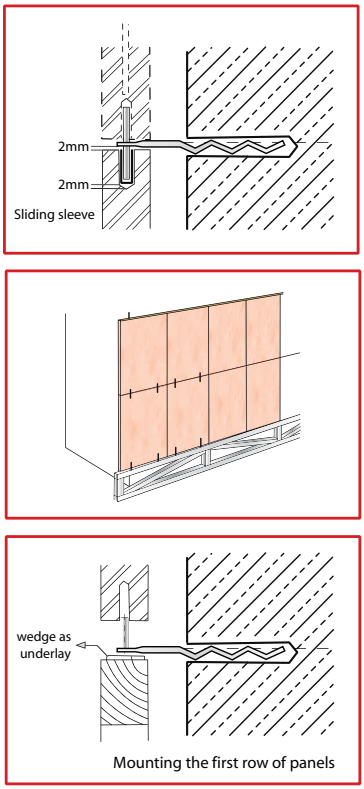




MOUNTING INSTRUCTIONS FOR STANGLE MORTAR ANCHOR

Arrangement of fixing system in horizontal joint

Take the exact measurements of the building façade, allowing for existing tolerances.
Cut out recesses in thermal insulation, sufficiently large for natural-stone anchors.
Drill anchor holes and remove drilling dust.
Erect support frame for bottom row of panels.
Wet anchor holes and fill with cement mortar.
Insert support anchor for bottom row of panels and underlay with wedges.
Pack cement mortar in anchor holes.
Insert cut-out thermal insulation for exact fit.
Drill anchor-pin holes in first-row panels and fill with mortar. Insert sliding sleeve at top and then place natural-stone panel on support anchor; align top edge of panel and fix provisionally and with wall hook, etc.
Insert support anchor for second row of panels.
Provide clear space of 2mm between top edge of bottom row of panels and support anchor of second row.



Mounting the first row of panels

Installation Steps

Anchoring in vertical joint

1. Start installation at the left hand of the building.
2. Position the first anchor under left bottom corner of the panel and install in the structure.
3. Position the first stone panel onto the first support anchor and wedge the right hand side.
4. Fasten the support anchor and restraint anchor for the first vertical joint and adjust.
5. Push the anchor pin through the bracket and push into the sliding sleeve.
6. Fill the pin holes of the second stone panel with mortar.
7. Push the second panel up to the first panel (leave a gap of 2mm on the sliding sleeve side).
8. Fit the next support anchor and restraint anchor.
9. Adjust, and continue with the panel sequence.
10. The second - last panel is anchored at the right - hand edge in the vertical joint with one-way pins.
11. The last panel at the right - hand edge of the building is placed onto 2 support anchors in the horizontal joint.

Anchoring in horizontal joint

1. Drill holes in the structure for the support anchors needed for the first and second row of panels.
2. Align support anchors and fasten to the structure.
3. Fill the pin holes of the first panel with mortar and place the first panel on the bottom anchors.
4. Supporting the panel, adjust its second row support anchors to leave a gap (joint) of at least 2.5 mm between the top edge of the panel and the under - side of the second row support anchors
5. Push the plastic sliding sleeve into the top pin through the bracket and into the sleeve below.
6. Working left to right, repeat these steps for the first row and subsequent rows of the panels.

THE RANGE OF PRODUCTION

The problems inherent in the fixing of cladding and their respective solutions are confronted by SFSP/STANGLE through either of two well-distinct approaches:

A) Standard fixing solutions:
Which have been done in response to the most representative and demanded dimensional characteristics.
These products come to be illustrated in the chapter, "Standard Types".

B) Special fixing solutions:
For which SFSP/STANGLE has organized a staff of specialized technicians, in grade to provide a series of services at the complete disposal of the client. For greater detail, we shall illustrate these additional services to which our clients may avail themselves, as follows:

- Consultation service - Designing service - Testing service - Quality control service - Installation service

Consultation service

SFSP/STANGLE puts its entire technical staff specialized in fixing systems, at the complete disposal of the client, whenever indications regarding the most opportune decisions and methods to be adopted for the correct realization of any cladding fixing project are required.
In addition, upon the request of the client, technical visits may be effective in the work yard, for the purposes of making realistic estimates, providing technical advice prior to construction or for a follow-up in regard to the correct utilization of the advised fixing systems.

Designing service

SFSP/STANGLE can affect a performance study and the complete designing of the most opportune fixing system for the cladding of buildings with marble facings, or facings of other materials.
The Design Department, after having received the essential information, will develop the project in respect to the necessary specifications supplied by the client.
The primary objective is to provide best solutions to problems posed by the respective project.

Testing service

SFSP grants particular importance to this structure, without which it would be difficult to make and manage an archive of knowledge that allows the preparation of new and advanced technical solutions to be subsequently applied for the perfection and maximum reliability of each specific project.
In order to attain this aim, an effective system of collaboration has been evolved with testing centers.
In fact, SFSP is able to provide the documentation belonging to the trial and testing of its own products, whenever requested by interested parties.

Quality control service

Quality represents one of the most essential characteristics of the finished product for SFSP.
In accordance with this concept, the company invests energy, which results in additional advantages for the client.
Control operations effected upon the raw material, upon the half-finished work-piece, and further verifications upon the finished product, mean guarantees in regard to the component materials, exact conformity with the desired dimensional features and the faultless realization of even the smallest details.

Installation service

SFSP is also ready to provide assistance service and to carry out the laying of the building cladding with specialized personnel.
Our technical staff is at your complete disposal in order to supply any further clarification you desire.

Product range

SFSP Steel angle range covers a wide variety of cavity, widths and load capacity.
The steel angle consists of two main components, a bracket with a vertical slot, and a threaded flat head bolt with dowel pin.
The vertical slot allows for up and down adjustment for connecting to the structure.
The threaded flat head bolt allows in and out adjustment to accommodate variations in cavities Wide steel angles can be bolted to C-Channels for maximum adjustment, or installed using drilled bolts.

Steel angles are available in several configurations with a choice of either full or half dowel pins. Full dowel pins have a knurled zone to prevent the pin dropping through the hole in the flat head bolt.

INTERNATIONAL STANDARDS FOR CLADDING DESIGN

Design & Calculation Standards

Reference is made to the following standards for the design and structural calculations of Natural Stone Fixing Systems.

American Standards:

Uniform Building Code 1997-Volume 2
ASTM A 276 Standard specification for stainless steel bars and shapes.
ASTM 666 Standard specification for annealed or cold-worked austenitic stainless steel sheets.
ASTM C1354 / C1354M - 09 Standard Test Method for Strength of Individual Stone Anchorages in Dimension Stone

British Standards:

BS 8298 Design and installation of natural stone cladding.
BS 1449 Part 2 Steel plates, sheets and strips stainless and heat resisting.
BS 6105 Corrosion resistant stainless steel fasteners.
BS 5950 Structural use of steel work in building.
CP3, Chapter 5, Part 2 Wind loads.
BS 970 Part 3 1991, Mechanical properties for stainless steel.

German Standards:

DIN 1045 Concrete and reinforced concrete, design and dimensioning.
DIN 1053 Masonry, design and dimensioning.
DIN 1055 Design loads for buildings.
DIN 18 516 Cladding for external walls.
DIN 18 800 Steel structures, design and dimensioning.
DIN 18 801 Steel framed structures.

L - BRACKETS

Support Bracket

The structural analysis fully considers the dead load of panel, imposed wind loads and thermal stresses in accordance with relevant DIN standards.

Loads caused by earthquakes can be transferred into the anchoring base.

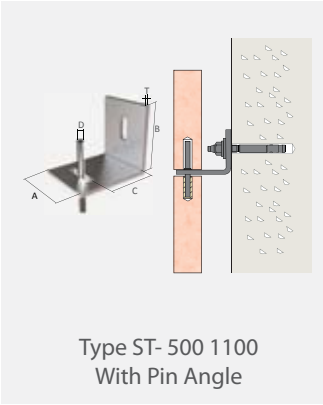
The support and restraint brackets are fixed using expansion anchors, chemical anchors, etc.

Using expansion bolts, an installation of the facade is also possible during the winter months.

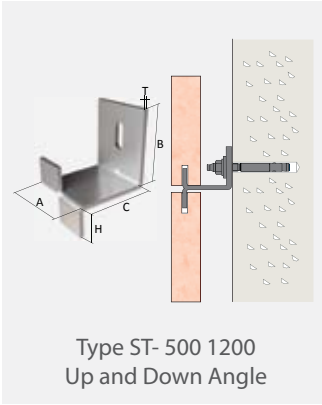
Due to the small drill hole dimensions of the expansion bolts, the facade can be installed very quickly.

L- BRACKETS ST-500

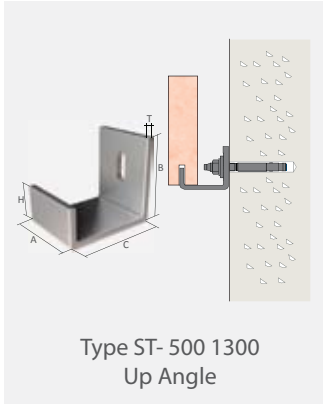
L - Brackets



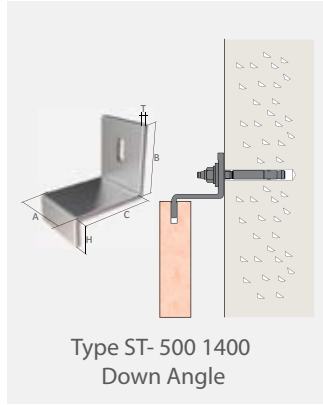
Type ST- 500 1100
With Pin Angle



Type ST- 500 1200
Up and Down Angle



Type ST- 500 1300
Up Angle



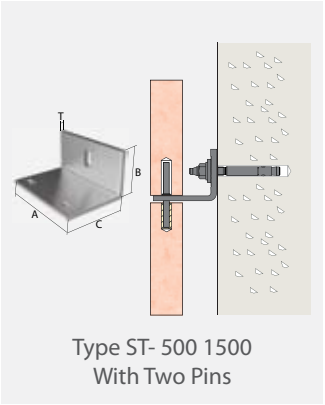
Type ST- 500 1400
Down Angle

Load Table for ST-1100/1200/1300/1400/1700.

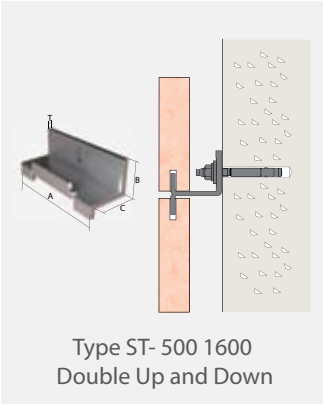
Materials: SS304, SS316, SS316L, SS316TI, S235JR-MG, S235JR-HDG ≤ 50°C 24h average temperature

Leg B B mm	Cavity to Pin C mm	Dead load max DL kN	Wind load max WL ± kN	Bracket Width A mm	Bracket Thickness T mm	Ø Pin mm	Anchor Comb. Force kN*
45	30	0.06	0.11	35	2	4	1.40
45	35			40	2	4	1.60
45	40			35	3	4	1.70
45	45			35	3	4	1.90
45	50			35	3	4	2.00
45	30	0.09	0.17	35	3	4	2.30
45	35			35	3	4	2.60
45	40			35	3	4	2.80
45	45			35	3	4	3.10
45	50			40	3	4	3.30
45	30	0.15	0.28	40	3	4	3.60
45	35			40	3	4	4.00
45	40			35	4	4	4.40
50	45			35	4	4	3.40
50	50			35	4	4	3.70
45	30	0.20	0.33	35	4	4	4.60
45	35			35	4	4	5.10
45	40			35	4	4	5.60
50	45			40	4	4	4.40
50	50			40	4	4	4.70

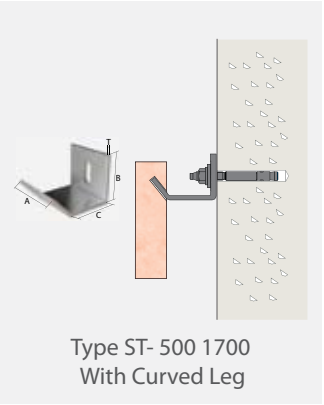
Loads per 1 bracket
If loads are bigger or dimensions are different, individual calculation is necessary
* with safety 3.0



Type ST- 500 1500
With Two Pins



Type ST- 500 1600
Double Up and Down



Type ST- 500 1700
With Curved Leg

Load Table for ST-1500/1600.

Materials SS304, SS316, SS316L, SS316TI, S235JR-MG, S235JR-HDG ≤ 50°C 24h average temperature

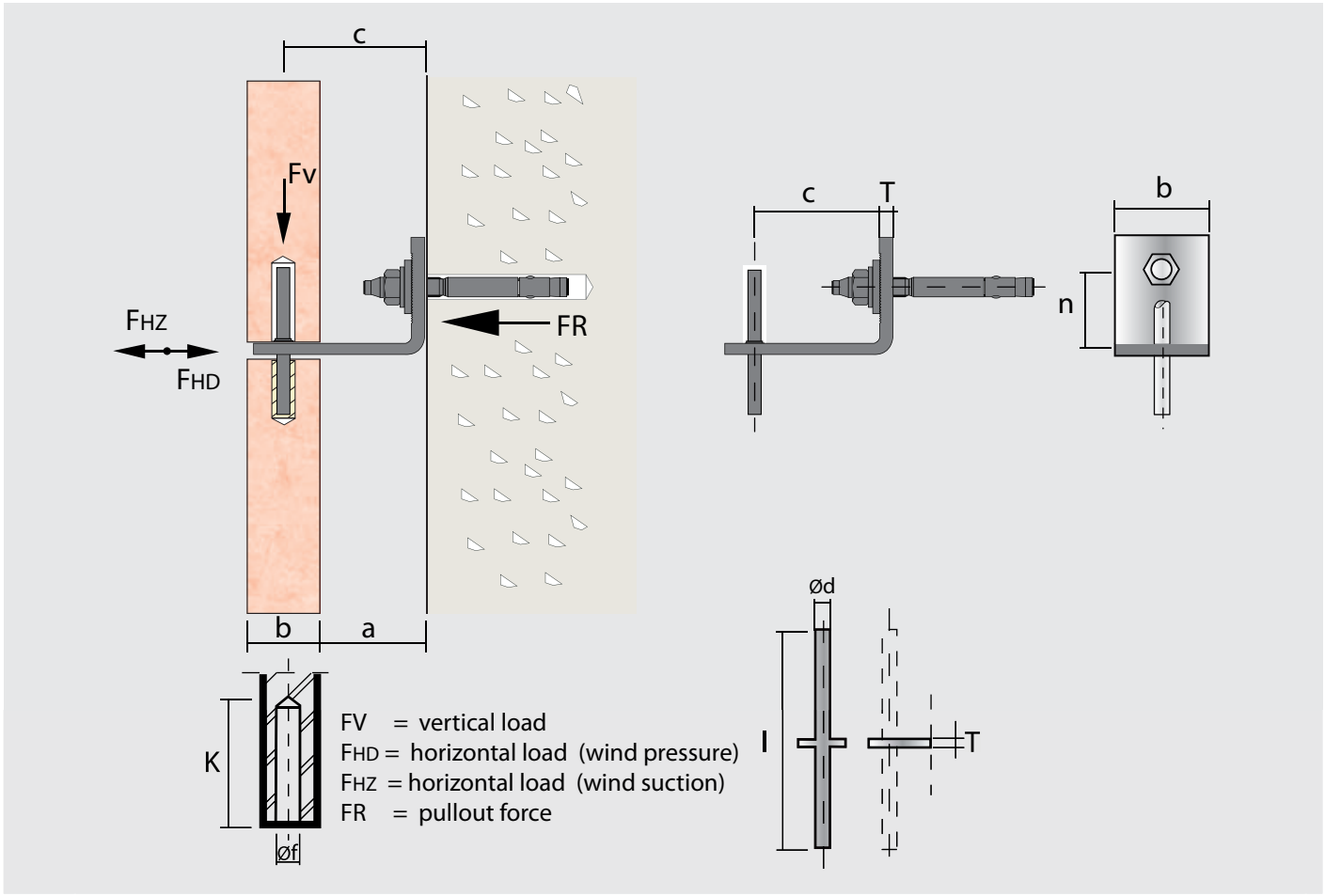
Leg B B mm	Cavity to Pin C mm	Dead load max DL kN	Wind load max WL ± kN	Bracket Width A mm	Bracket Thickness T mm	Ø Pin mm	Anchor Comb. Force kN *
50	30	0.40	0.56	120	3	2 x 4	5.80
50	35			120	3	2 x 4	6.30
50	40			120	3	2 x 4	6.80
50	45			140	3	2 x 4	7.30
50	50			120	4	2 x 4	8.90
50	30	0.50	0.70	120	3	2 x 4	8.10
50	35			130	3	2 x 4	8.90
50	40			120	4	2 x 4	9.60
50	45			120	4	2 x 4	10.40
50	50			120	4	2 x 4	11.10
60	30	0.60	0.84	140	3	2 x 4	7.00
60	35			120	4	2 x 4	7.90
60	40			120	4	2 x 4	8.40
60	45			120	4	2 x 4	8.90
60	50			120	4	2 x 4	9.40
60	30	0.70	0.98	120	4	2 x 4	8.60
60	35			120	4	2 x 4	9.20
60	40			120	4	2 x 4	9.80
60	45			130	4	2 x 4	10.40
60	50			140	4	2 x 4	11.00

Loads per 1 bracket
If loads are bigger or dimensions are different, individual calculation is necessary
* with safety 3.0

SFSP

L- BRACKETS ST-500

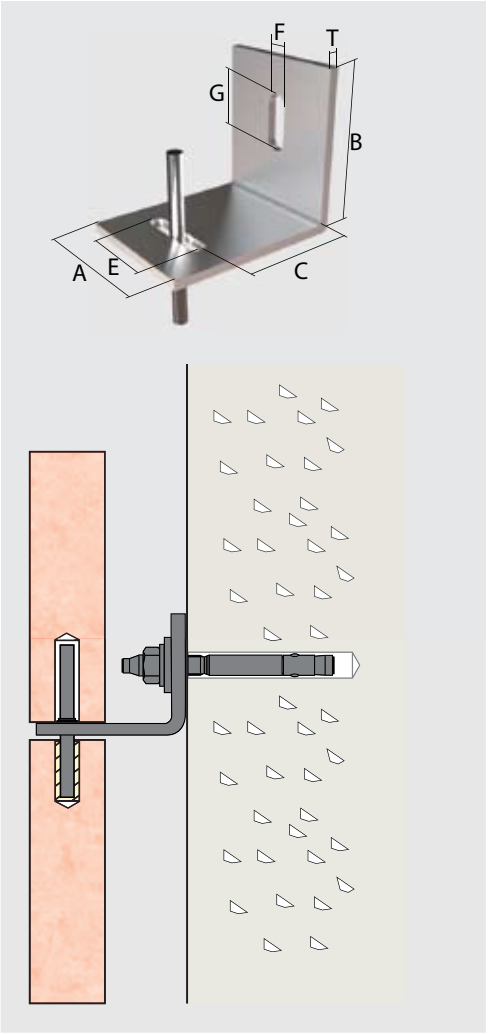
System Type ST 500 -1100 with Pin



L-Bracket (Standard & Serrated) with Pin | Type ST- 500 1100

Materials SS304, SS316, SS316L, SS316TI, S235JR-MG, S235JR-HDG ≤ 50°C 24h average temperature
Standard items:

Item No.	T	A	B	C	Pin	Slot Fx G
1100-35.45.30.2	2	35	45	30	4	6.5 x 22
1100-40.45.35.2	2	40	45	35	4	6.5 x 22
1100-35.45.30.3	3	35	45	30	4	6.5 x 22
1100-40.45.30.3	3	40	45	30	4	8.5 x 22
1100-35.45.35.3	3	35	45	35	4	6.5 x 22
1100-40.45.35.3	3	40	45	35	4	8.5 x 22
1100-35.45.40.3	3	35	45	40	4	6.5 x 22
1100-35.45.30.4	4	35	45	30	4	8.5 x 22
1100-35.45.35.4	4	35	45	35	4	8.5 x 22
1100-35.45.40.4	4	35	45	40	4	8.5 x 22
1100-35.50.45.4	4	35	50	45	4	8.5 x 22
1100-40.50.45.4	4	40	50	45	4	8.5 x 22

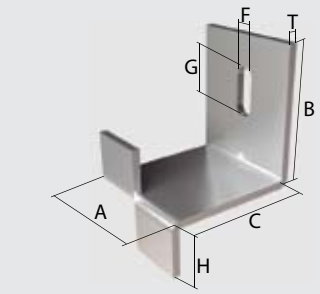


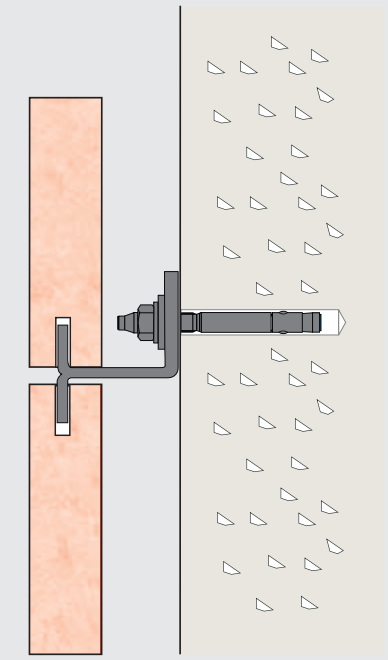
SYSTEM TYPE ST 500 -1200 WITH UP & DOWN LEGS

L-Bracket (Standard & Serrated) Up and Down | Type ST- 500 1200

Materials SS304, SS316, SS316L, SS316TI, S235JR-MG, S235JR-HDG ≤ 50°C 24h average temperature
Standard items:

Item No.	T	A	B	C	H	Slot
1200-35.45.30.2	2	35	45	30	15	6.5 x 22
1200-40.45.35.2	2	40	45	35	15	6.5 x 22
1200-35.45.30.3	3	35	45	30	15	6.5 x 22
1200-40.45.30.3	3	40	45	30	15	8.5 x 22
1200-35.45.35.3	3	35	45	35	15	6.5 x 22
1200-40.45.35.3	3	40	45	35	15	8.5 x 22
1200-35.45.40.3	3	35	45	40	15	6.5 x 22
1200-35.45.30.4	4	35	45	30	15	8.5 x 22
1200-35.45.35.4	4	35	45	35	15	8.5 x 22
1200-35.45.40.4	4	35	45	40	15	8.5 x 22
1200-35.50.45.4	4	35	50	45	15	8.5 x 22
1200-40.50.45.4	4	40	50	45	15	8.5 x 22



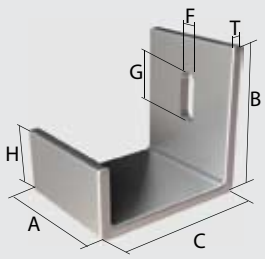


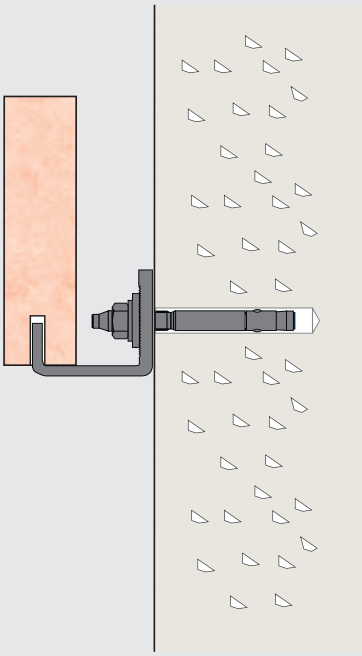
SYSTEM TYPE ST 500 -1300 WITH UP LEG

L-Bracket (Standard & Serrated) Up | Type ST- 500 1300

Materials SS304, SS316, SS316L, SS316TI, S235JR-MG, S235JR-HDG ≤ 50°C 24h average temperature
Standard items:

Item No.	T	A	B	C	H	Slot
1300-35.45.30.2	2	35	45	30	15	6.5 x 22
1300-40.45.35.2	2	40	45	35	15	6.5 x 22
1300-35.45.30.3	3	35	45	30	15	6.5 x 22
1300-40.45.30.3	3	40	45	30	15	8.5 x 22
1300-35.45.35.3	3	35	45	35	15	6.5 x 22
1300-40.45.35.3	3	40	45	35	15	8.5 x 22
1300-35.45.40.3	3	35	45	40	15	6.5 x 22
1300-35.45.30.4	4	35	45	30	15	8.5 x 22
1300-35.45.35.4	4	35	45	35	15	8.5 x 22
1300-35.45.40.4	4	35	45	40	15	8.5 x 22
1300-35.50.45.4	4	35	50	45	15	8.5 x 22
1300-40.50.45.4	4	40	50	45	15	8.5 x 22



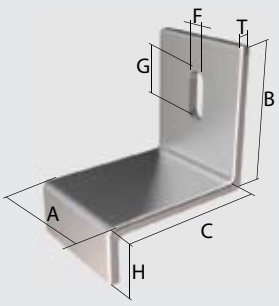


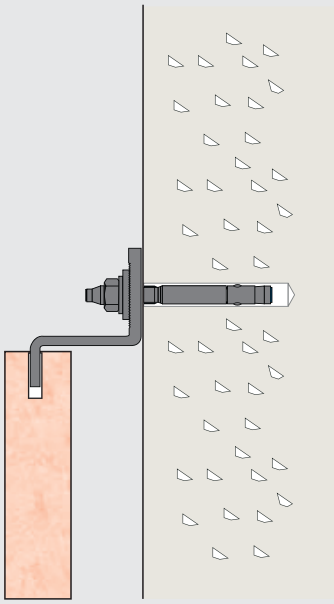
SYSTEM TYPE ST 500 -1400 WITH DOWN LEG

L-Bracket (Standard & Serrated) Down | Type ST- 500 1400

Materials SS304, SS316, SS316L, SS316TI, S235JR-MG, S235JR-HDG ≤ 50°C 24h average temperature
Standard items:

Item No.	T	A	B	C	H	Slot
1400-35.45.30.2	2	35	45	30	20	6.5 x 22
1400-40.45.35.2	2	40	45	35	20	6.5 x 22
1400-35.45.30.3	3	35	45	30	20	6.5 x 22
1400-40.45.30.3	3	40	45	30	20	8.5 x 22
1400-35.45.35.3	3	35	45	35	20	6.5 x 22
1400-40.45.35.3	3	40	45	35	20	8.5 x 22
1400-35.45.40.3	3	35	45	40	20	6.5 x 22
1400-35.45.30.4	4	35	45	30	20	8.5 x 22
1400-35.45.35.4	4	35	45	35	20	8.5 x 22
1400-35.45.40.4	4	35	45	40	20	8.5 x 22
1400-35.50.45.4	4	35	50	45	20	8.5 x 22
1400-40.50.45.4	4	40	50	45	20	8.5 x 22



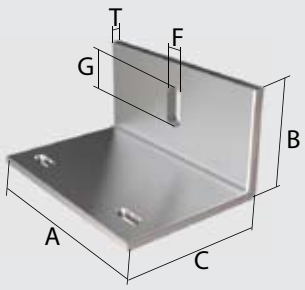


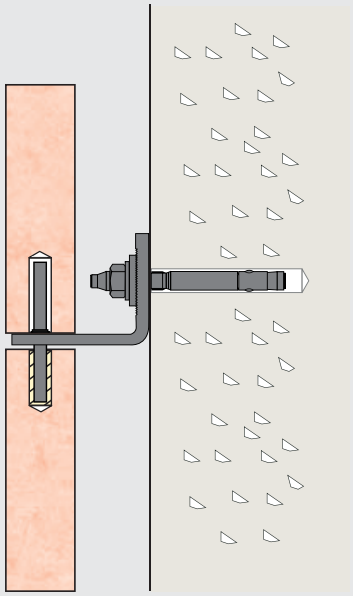
SYSTEM TYPE ST 500 -1500 WITH DOUBLE PIN

L-Bracket (Standard & Serrated) with Two Pins | Type ST- 500 1500

Materials SS304, SS316, SS316L, SS316TI, S235JR-MG, S235JR-HDG ≤ 50°C 24h average temperature
Standard items:

Item No.	T	A	B	C	Pin	Slot
1500-120.50.30.3	3	120	50	30	2x 4	8.5 x 22
1500-120.50.35.3	3	120	50	35	2x 4	8.5 x 22
1500-120.50.40.3	3	120	50	40	2x 4	8.5 x 22
1500-140.60.30.3	3	140	60	30	2x 4	8.5 x 22
1500-140.50.45.3	3	140	50	45	2x 4	8.5 x 22
1500-120.60.30.4	4	120	60	30	2x 4	8.5 x 22
1500-120.60.35.4	4	120	60	35	2x 4	8.5 x 22
1500-120.50.40.4	4	120	50	40	2x 4	10.5 x 22
1500-120.50.45.4	4	120	50	45	2x 4	10.5 x 22
1500-120.50.50.4	4	120	50	50	2x 4	8.5 x 22
1500-120.60.50.4	4	120	60	50	2x 4	10.5 x 22
1500-140.60.50.4	4	140	60	50	2x 4	10.5 x 22





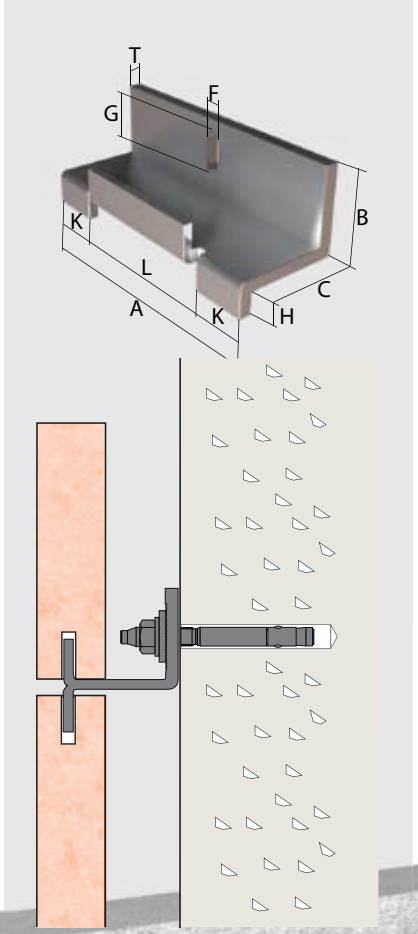
L-Bracket (Standard & Serrated) | Type ST- 500 1600 Double Up and Down

L-Bracket (Standard & Serrated) Double Up and Down | Type ST- 500 1600

Materials SS304, SS316, SS316L, SS316TI, S235JR-MG, S235JR-HDG ≤ 50°C 24h average temperature
Standard items:

Item No.	T	A	B	C	H	L	K	Slot
1600-120.50.30.3	3	120	50	30	15	A/2	A/4	8.5 x 22
1600-120.50.35.3	3	120	50	35	15	A/2	A/4	8.5 x 22
1600-120.50.40.3	3	120	50	40	15	A/2	A/4	8.5 x 22
1600-140.60.30.3	3	140	60	30	15	A/2	A/4	8.5 x 22
1600-140.50.45.3	3	140	50	45	15	A/2	A/4	8.5 x 22
1600-120.60.30.4	4	120	60	30	15	A/2	A/4	8.5 x 22
1600-120.60.35.4	4	120	60	35	15	A/2	A/4	8.5 x 22
1600-120.50.40.4	4	120	50	40	15	A/2	A/4	10.5 x 22
1600-120.50.45.4	4	120	50	45	15	A/2	A/4	10.5 x 22
1600-120.50.50.4	4	120	50	50	15	A/2	A/4	8.5 x 22
1600-120.60.50.4	4	120	60	50	15	A/2	A/4	10.5 x 22
1600-140.60.50.4	4	140	60	50	15	A/2	A/4	10.5 x 22

L= A/2
K=A/4

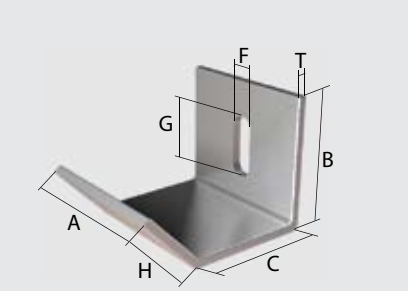


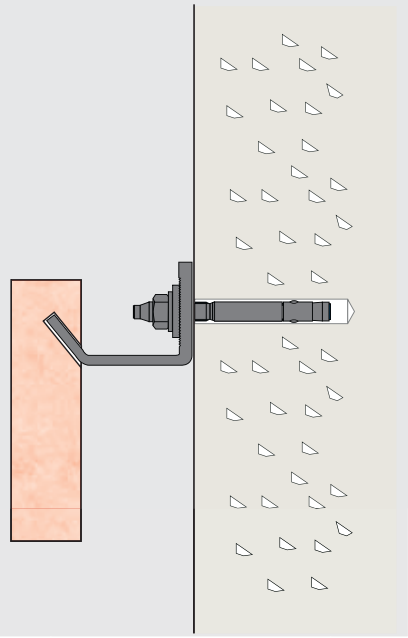
SYSTEM TYPE ST 500 -1700 WITH CURVED LEG

L-Bracket (Standard & Serrated) with Curved Leg | Type ST- 500 1700

Materials SS304, SS316, SS316L, SS316TI, S235JR-MG, S235JR-HDG ≤ 50°C 24h average temperature
Standard items:

Item No.	T	A	B	C	H	Slot
1700-35.45.30.2	2	35	45	30	20	6.5 x 22
1700-40.45.35.2	2	40	45	35	20	6.5 x 22
1700-35.45.30.3	3	35	45	30	20	6.5 x 22
1700-40.45.30.3	3	40	45	30	20	8.5 x 22
1700-35.45.35.3	3	35	45	35	20	6.5 x 22
1700-40.45.35.3	3	40	45	35	20	8.5 x 22
1700-35.45.40.3	3	35	45	40	20	6.5 x 22
1700-35.45.30.4	4	35	45	30	20	8.5 x 22
1700-35.45.35.4	4	35	45	35	20	8.5 x 22
1700-35.45.40.4	4	35	45	40	20	8.5 x 22
1700-35.50.45.4	4	35	50	45	20	8.5 x 22
1700-40.50.45.4	4	40	50	45	20	8.5 x 22





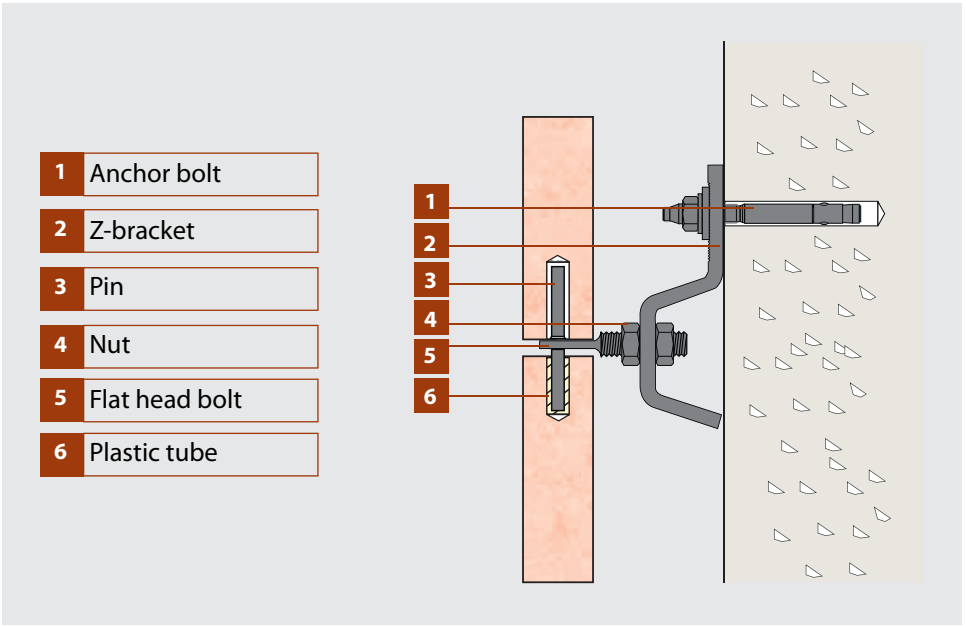
Z- BRACKETS

SYSTEM TYPE ST- 600 -1100 WITH RETURNED LEG

Z-Bracket with Returned Leg

Application
According to DIN 18515, all cladding panels which are larger than 0.1 m² have to be anchored.

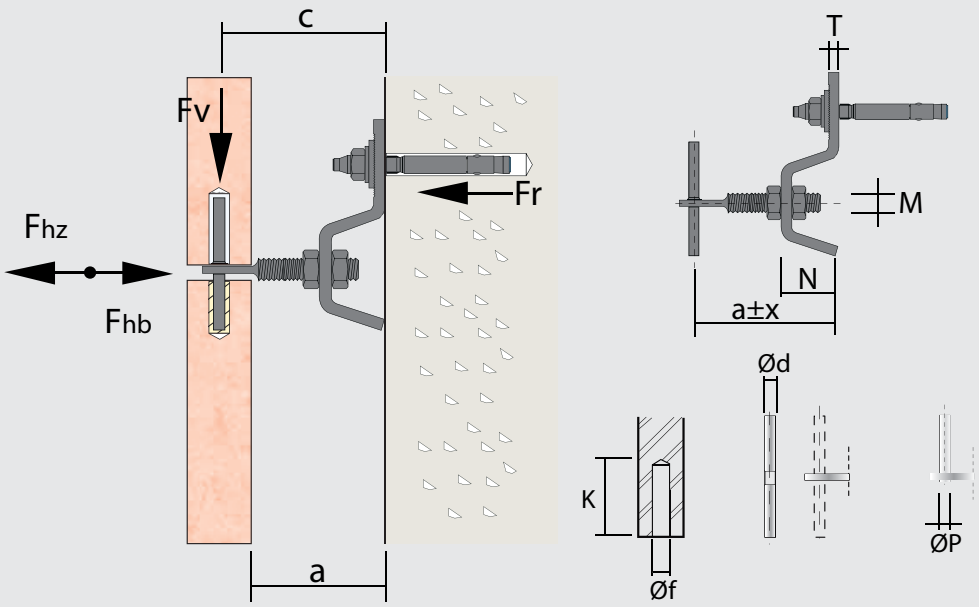
Material
Manufactured from stainless steel AISI 304, 316, 316L and 316Ti
Adjustability in two directions.



Advantages
- The panels are secured to the anchoring base material with absolute safety.
- Manufactured from stainless steel for high corrosion resistance and better durability.
- The support and restraint brackets are adjustable in 2 directions.
- The brackets are fixed into the anchoring base by means of anchors. Due to the small drill hole dimensions of the anchors, the facade can be installed very quickly. The small size of drill hole into the anchoring base material means that heavy drilling equipment is not required.

SYSTEM TYPE ST- 600 -1100 WITH RETURNED LEG

Z-Bracket with Returned Leg Horizontal Joint (Standard & Serrated) Type ST- 600 1100

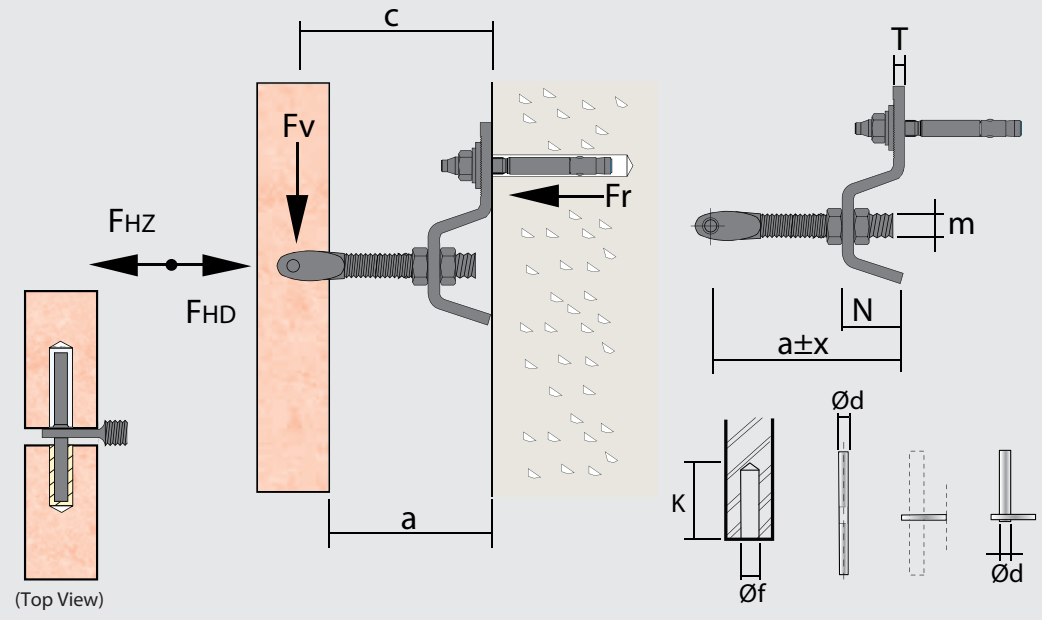


Anchoring base:
According to the anchor bolt.
a = cavity to backside to panel

Adjustibility:
in 2 directions x = ± 10 mm
Z = ± 05 mm

Fv = vertical load
Fhd = horizontal load (wind pressure)
Fhz = horizontal load (wind suction)
Fr = pullout force

Z-Bracket with Returned Leg Vertical joint (Standard & Serrated) Type ST- 600 1100



SYSTEM TYPE ST- 600 -1100 WITH RETURNED LEG

Z-Bracket with Returned Leg | ST-600-1100

Materials SS304, SS316, SS316L, SS316TI, S235JR-MG, S235JR-HDG ≤ 50°C 24h average temperature
Standard items:

Item No.	Width (W)	Thickness (T)	Offset (N)	FHB	Ø Pin	Slot
600-1100 -35.3.20	35	3	20	M8	4	6.5 x 22
600-1100 -40.3.30	40	3	30	M8	4	6.5 x 22
600-1100 -45.3.40	45	3	40	M8	4	6.5 x 22
600-1100 -50.3.50	50	3	50	M8	4	6.5 x 22
600-1100 -40.4.20	40	4	20	M10	5	8.5 x 22
600-1100 -40.4.30	40	4	30	M10	5	8.5 x 22
600-1100 -45.4.40	45	4	40	M10	5	8.5 x 22
600-1100 -50.4.50	50	4	50	M10	5	8.5 x 22
600-1100 -40.5.20	40	5	20	M12	6	8.5 x 22
600-1100 -45.5.30	45	5	30	M12	6	8.5 x 22
600-1100 -45.5.40	45	5	40	M12	6	8.5 x 22
600-1100 -50.5.50	50	5	50	M12	6	8.5 x 22

Load Table of Z-Bracket with Returned Leg

Materials SS304, SS316, SS316L, SS316TI, S235JR-MG, S235JR-HDG ≤ 50°C 24h average temperature

Bracket Offset mm	Cavity to Pin min - max mm (e)	Dead load max DL kN	Wind load max WL ± kN	Bracket Width mm	Bracket Thickness (T) mm	Ø Pin mm	FHB A2-70 A4-70	Anchor Comb. Force kN *
20	50-60	0.16	0.21	35	3	4	M8	1.90
30	60-70			40	3	4	M8	2.00
40	70-80			45	3	4	M8	2.10
50	80-90			50	3	4	M8	2.10
60	90-100			40	4	4	M8	2.10
70	100-110			40	4	4	M8	2.10
20	50-60	0.28	0.37	40	4	5	M10	3.40
30	60-70			40	4	5	M10	3.60
40	70-80			45	4	5	M10	3.60
50	80-90			50	4	5	M10	3.70
60	90-100			50	4	5	M10	3.70
70	100-110			55	4	5	M10	3.80
20	50-60	0.45	0.66	40	5	6	M12	6.00
30	60-70			45	5	6	M12	6.00
40	70-80			45	5	6	M12	6.10
50	80-90			50	5	6	M12	6.20
60	90-100			55	5	6	M12	6.30
70	100-110			60	5	6	M12	6.30

Loads per 1 bracket
If loads are bigger or dimensions are different, individual calculation is necessary
* with safety 3,0

SYSTEM TYPE ST- 600 -1100 WITH RETURNED LEG

Z-Bracket with Returned Leg Horizontal Joint

The structural analysis fully considers the dead load of the panel, imposed wind loads and thermal stresses, in accordance with relevant DIN standards.

Loads caused by earthquakes can be transferred into the anchoring base.

The support and restraint brackets are fixed using expansion anchors, chemical anchors, etc...

The support and restraint brackets are adjustable in 2 directions.

Due to the adjustability of the brackets and the small drill hole dimensions of the anchors, the façade can be installed very quickly.

The restraint anchors of the system 1 to 5 are interchangeable so that any problem in the fixing can be solved optimally.

SYSTEM TYPE ST- 600 -1100 WITH RETURNED LEG

Z-Bracket with Returned Leg Vertical Joint

The structural analysis fully considers the dead load of panel, imposed wind loads and thermal stresses, in accordance with relevant DIN standards.

Loads caused by earthquakes can be transferred into the anchoring base.

The support and restraint brackets are fixed using expansion anchors, chemical anchors, etc.

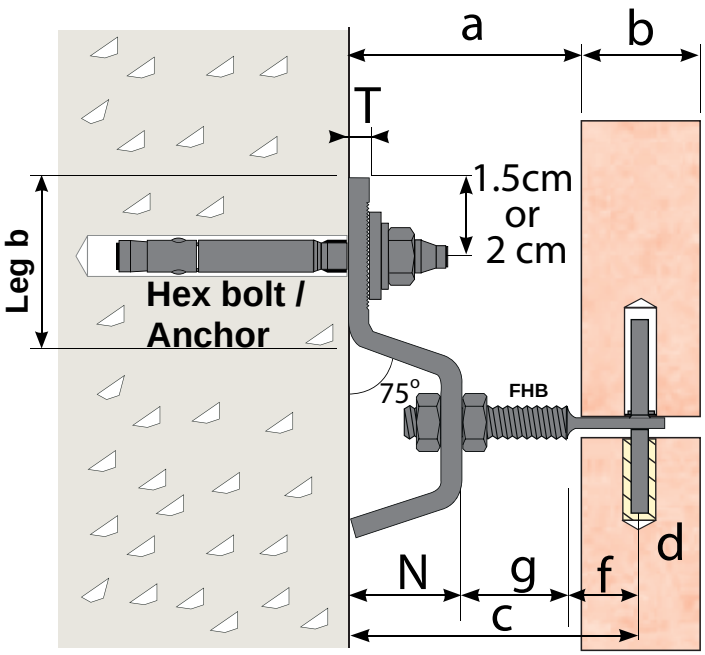
The support and restraint brackets are adjustable in 2 directions.

Due to the adjustability of the brackets and the small drill hole dimensions of the anchors, the façade can be installed very quickly.

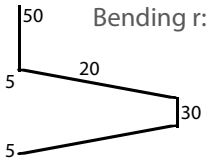
CASE STUDY

PROOF FOR Z-RETURNED BRACKET ACCORDING TO DIN 18.800

Z-returned bracket	
a	Cavity to back side panel
b	Panel thickness
T	Bracket thickness
d	Diameter of pin
c	Cavity to pin
f	Flat head parts
g	Threaded part
N	Bracket offset



Bending detail:



Bending r: 6mm min.

Facade panel:

Width =	800 mm
Height =	450 mm
Thickness =	30 mm

Cavity a =	40 ± 10 mm
Offset N =	25 mm
Cavity to Pin =	55 ± 5 mm

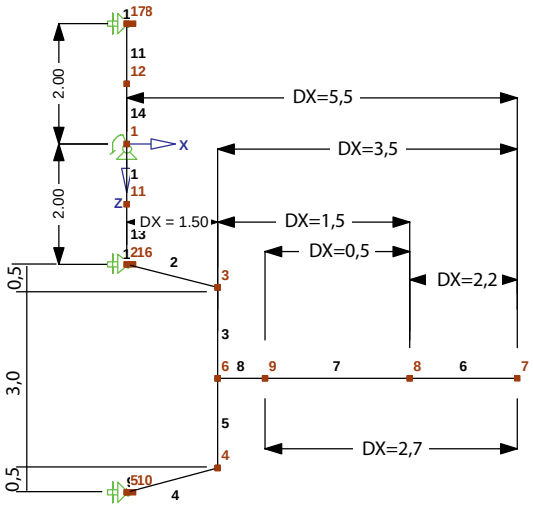
Facade bracket

Sec 1:	min. w1 =	8 mm
	t1 =	3 mm
Sec 2:	thread =	M8
Sec 3:	w3 =	40 mm
	t3 =	3 mm
Sec 4:	d =	4.0 mm
	l =	>= 40 mm

pieces in 1 joint:	2

STRUCTURAL DATA

Node Numbering
Element Numbering



Opposite Y-direction

1.259 cm

GENERAL DATA

LC No	LC Description	Factor	Combination Type	Dead Weight
1	Proper weight	1.0	Permanent	1.00
2	Wind pressure	1.0	Variable	-
3	Wind suction	1.0	Variable	-
4	Seismic load	1.0	Exceptional	-

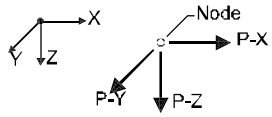
LOAD GROUPS

LG No	LG Description	Factor	Safety 8M	Load Cases in LG
1		1.00	1.10	1.35*LC1 + 1.50*LC2
2		1.00	1.10	1.35*LC1 + 1.50*LC3
3		1.00	1.10	LC1 + 1.50*LC3
4		1.00	1.10	LC1 + LC4
51	LC1 + LC2 (for deflection)	1.00	1.10	LC1 + LC2
52	LC1 + LC3 (for deflection)	1.00	1.10	LC1 + LC3

SFSP

PROOF FOR Z-RETURNED BRACKET ACCORDING TO DIN 18.800

Global Nodal Force



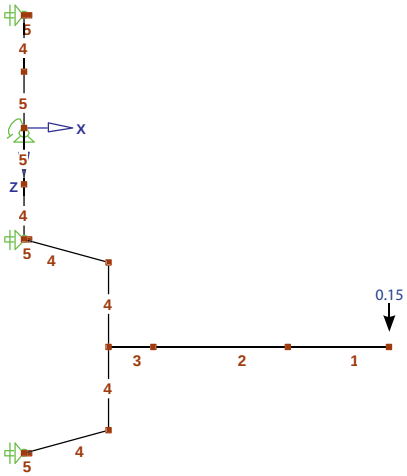
NODAL FORCES LC 1

No	Loaded Nodes	Nodal Forces		
		PX [kN]	PY [kN]	PZ [kN]
1	7	0.000	0.000	0.15

Opposite Y-direction

LOADS

LC 1 - Proper weight [kN]



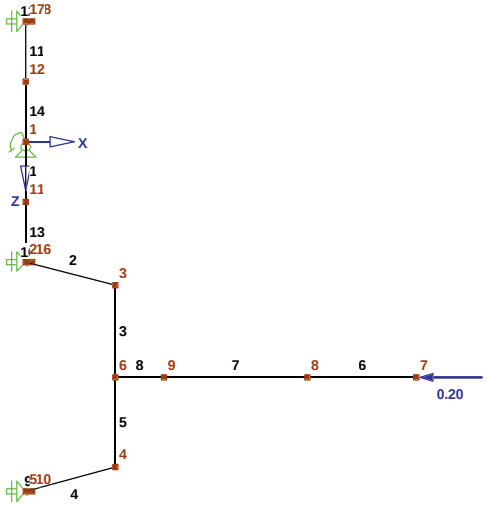
NODAL FORCES LC 1

No	Loaded Nodes	Nodal Forces		
		PX [kN]	PY [kN]	PZ [kN]
1	7	0.2	0.000	0.000

Opposite Y-direction

LOADS

LC 2 - Wind pressure [kN]



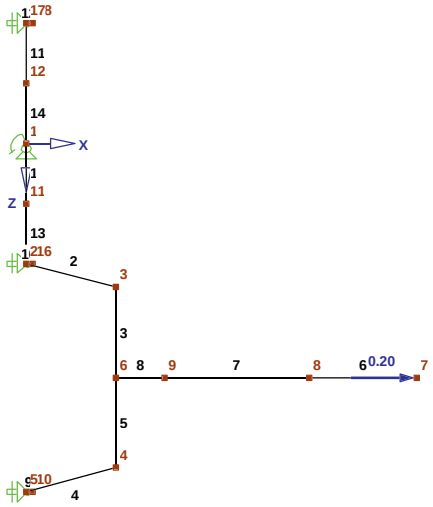
NODAL FORCES LC 3

No	Loaded Nodes	Nodal Forces		
		PX [kN]	PY [kN]	PZ [kN]
1	7	0.2	0.000	0.000

Opposite Y-direction

LOADS

LC 3 - Wind pressure [kN]



1.259 cm

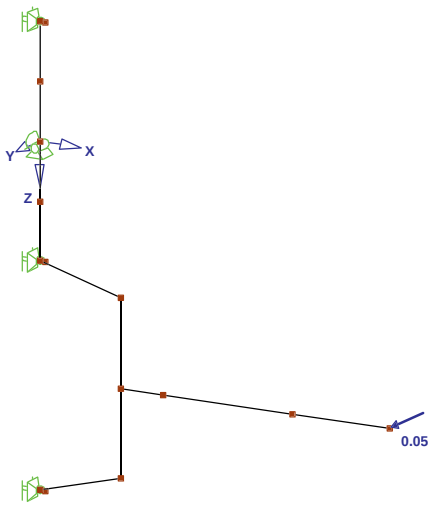
NODAL FORCES LC 1

No	Loaded Nodes	Nodal Forces		
		PX [kN]	PY [kN]	PZ [kN]
1	7	0.000	0.05	0.000

Isometric

LOADS

LC 4 - Seismic load [kN]



1.259 cm

PROOF FOR Z-RETURNED BRACKET ACCORDING TO DIN 18.800

LOAD COMBINATIONS

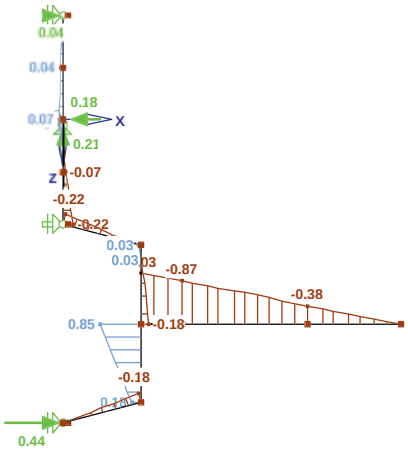
CO No	CO Description	Combination Criteria
1	LC1 or LC2 or LC3 or LC4	LG1 o LG2 o LG3 o LG4

LG-No	Factor Ny	Number Iterations	Eps-Convergence		Ny-fold Results	Tension Force Effect
			Existing	Wanted		
LG1	1.000	71	.00E+00	0.01	Yes	No
LG2	1.000	20	.25E-04	0.01	Yes	No
LG3	1.000	20	.14E-04	0.01	Yes	No
LG4	1.000	28	.92E-06	0.01	Yes	No
LG51	1.000	61	.00E+00	0.01	Yes	No
LG52	1.000	21	.16E-04	0.01	Yes	No

SISP

RESULTS

LG 1
Internal Forces M-2
Support Reactions



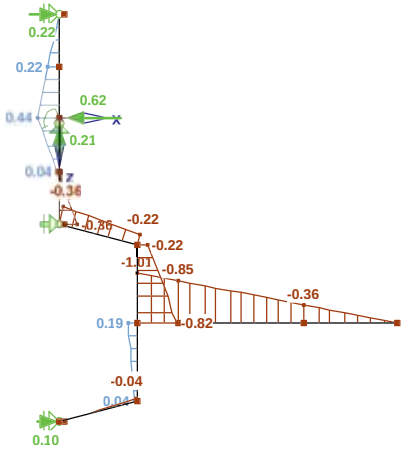
Opposite Y-direction

1.542kN cm
Max M-2:0.85, Mn M-2: -1.03kN cm

1.453 cm

RESULTS

LG 2
Internal Forces M-2
Support Reactions



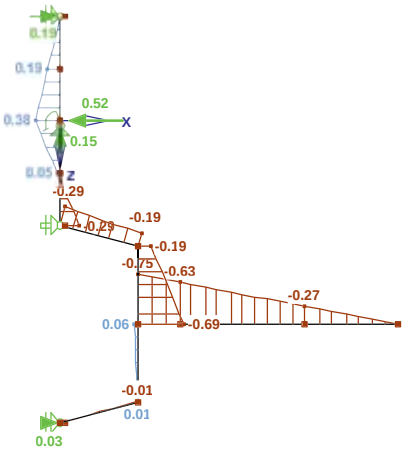
Opposite Y-direction

1.542kN cm
Max M-2:0.44, Mn M-2: -1.01kN cm

1.453 cm

RESULTS

LG 3
Internal Forces M-2
Support Reactions



Opposite Y-direction

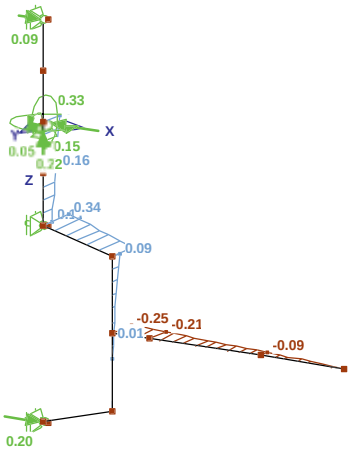
1.145kN cm

Max M-2:0.38, Mn M-2: -0.75kN cm

1.453 cm

RESULTS

LG 4
Internal Forces M-2
Support Reactions



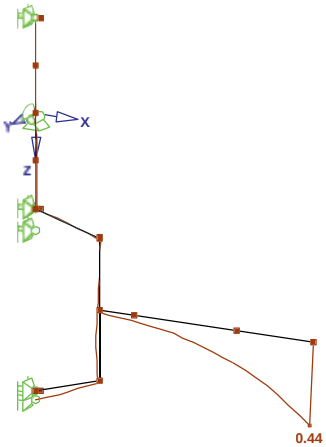
Isometric

Max M-3:0.34, Mn M-3: -0.25kN cm

0.507 kN cm

RESULTS

LG 51 - LC1 + LC2 (for deflection)
Deformations



Isometric

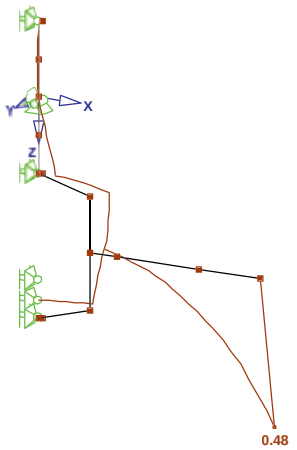
Max u: 0.44 mm
Factor for Deformations: 40

0.507 kN cm

PROOF FOR Z-RETURNED BRACKET ACCORDING TO DIN 18.800

RESULTS

LG 52 - LC1 + LC3 (for def lection)
Deformations



Max u: 0.48 mm
Factor for Deformations : 80

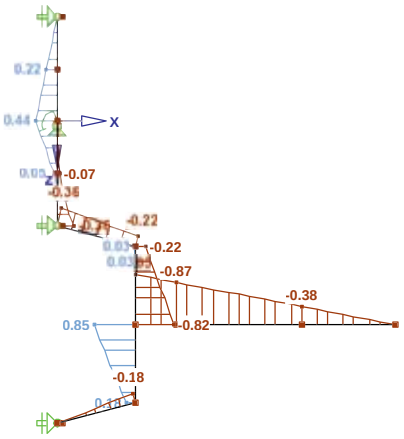
MAX/MIN/CORE SUPPORT FORCES AND SUPPORT MOMENTS

Node No	CO No		Support Forces [kN]			Support Moments [kN/cm]		
			PX	PY	PZ	MX	MY	MZ
1	CO1	Max P-X Min P-X LC in Max P-X: LG2 LC in Min P-X:	.62 .00	.00 .00	.21 .00	.00 .00	.00 .00	.00 .00
		Max P-Y Min P-Y LC in Max P-Y: LG4 LC in Min P-Y:	.29 .00	.05 .00	.15 .00	-.22 .00	.00 .00	.33 .00
		Max P-Z Min P-Z LC in Max P-Z: LG1 LC in Min P-Z:	.18 .00	.00 .00	.21 .00	.00 .00	.00 .00	.00 .00
		Max M-X Min M-X LC in Max M-X: LC in Min M-X: LG4	.00 .29	.00 .05	.00 .15	.00 -.22	.00 .00	.00 .33
		Max M-Y Min M-Y LC in Max M-Y: LG2 LC in Min M-Y:	.62 .00	.00 .00	.21 .00	.00 .00	.00 .00	.00 .00
		Max M-Z Min M-Z LC in Max M-Z: LG4 LC in Min M-Z:	.29 .00	.05 .00	.15 .00	-.22 .00	.00 .00	.33 .00
10	CO1	Max P-X Min P-X LC in Max P-X: LC in Min P-X: LG1	.00 -.44	.00 .00	.00 .00	.00 .00	.00 .00	.00 .00
		Max P-Y Min P-Y LC in Max P-Y: LC in Min P-Y: LG4	.00 -.20	.00 .00	.00 .00	.00 .00	.00 .00	.00 .00
16	CO1	Max P-X Min P-X LC in Max P-X: LC in Min P-X: LG1	.00 .00	.00 .00	.00 .00	.00 .00	.00 .00	.00 .00
		Max P-Y Min P-Y LC in Max P-Y: LC in Min P-Y: LG4	.00 .00	.00 .00	.00 .00	.00 .00	.00 .00	.00 .00
18	CO1	Max P-X Min P-X LC in Max P-X: LC in Min P-X: LG2	.00 -.22	.00 .00	.00 .00	.00 .00	.00 .00	.00 .00
		Max P-Y Min P-Y LC in Max P-Y: LC in Min P-Y:	.00 .00	.00 .00	.00 .00	.00 .00	.00 .00	.00 .00

SFSP

RESULTS

CO1 - LC1 or LC2 or LC3 or LC4
Max/Min Internal Forces M-2



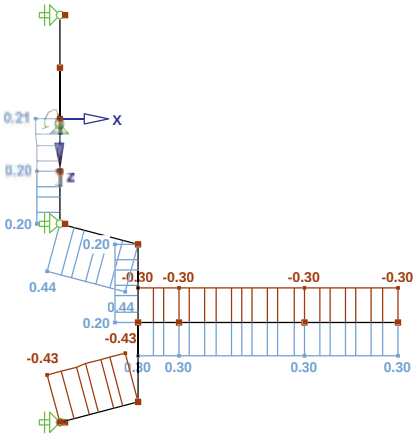
Opposite Y-direction

1.572kN/CM
Max M-2:0.85, Mn M-2: -1.03kN cm

1.453 CM

RESULTS

CO1 - LC1 or LC2 or LC3 or LC4
Max/Min Internal Forces N



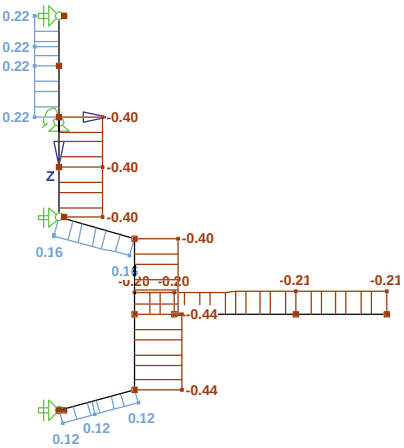
Opposite Y-direction

0.672kN
Max N:0.44, Mn N: -0.43kN

1.453 CM

RESULTS

CO1 - LC1 or LC2 or LC3 or LC4
Max/Min Internal Forces V-3



Isometric

0.693kN
Max V-3:0.22, Mn V-3: -0.44kN

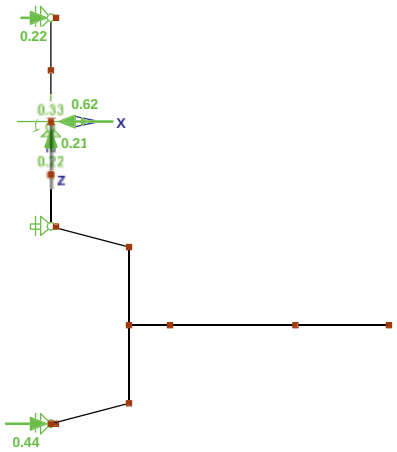
1.500 CM

PROOF FOR Z-RETURNED BRACKET ACCORDING TO DIN 18.800

Opposite Y-direction

RESULTS

CO1 - LC1 or LC2 or LC3 or LC4
Extreme Support Reactions



STEEL1 - Stress analysis

GENERAL DATA

ELEMENTS TO DESIGN	All	
LOAD CASES TO DESIGN	LG1	1.35*LC1 + 1.50*LC2
	LG2	1.35*LC1 + 1.50*LC3
	LG3	LC1 + 1.50*LC3
	LG4	LC1 + LC4

Mat No	Material Description	Material Code, Criterion	Allowable Stresses [kN/cm^2] at 50°c		
			Sigma	Tau	Sigma eq
1	SS-304	Stainless Steel	16.1	9.3	17.7
2	A-70	Stainless Steel	40.9	23.6	40.9

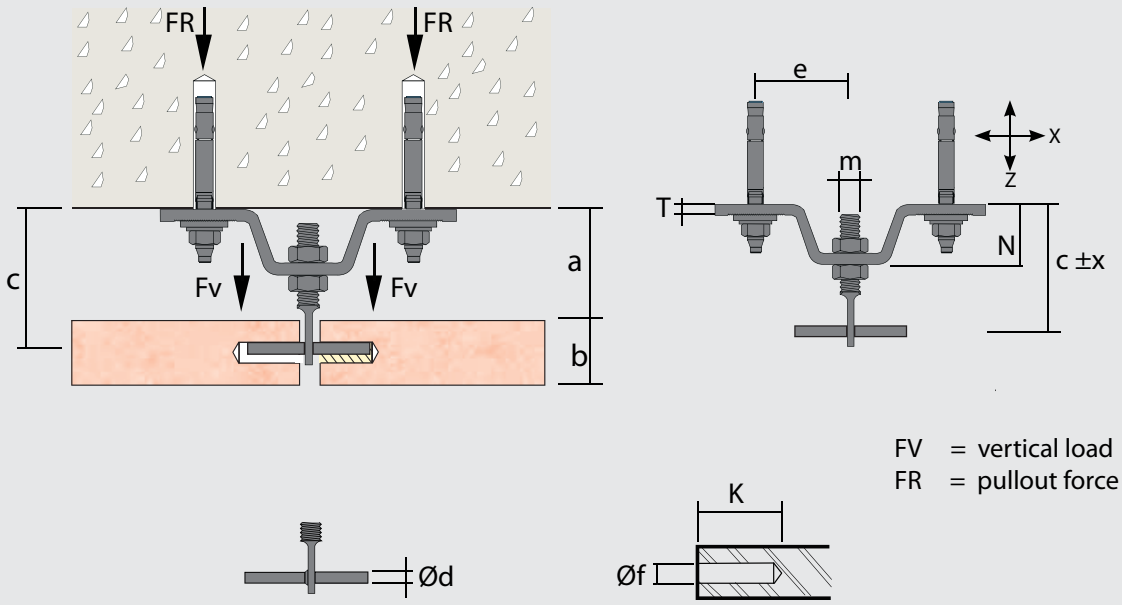
Stress Type	Elem No	x Loc [cm]	S Point No	LC No	Stress [kN/cm^2]		Stress Ratio
					existing	allowable	
Section No 1 - Flat 8/3							
Sigma Total	6	1.80	3	LG1	-32.92	40.90	0.80
Tau Total	6	0.00	5	LG1	1.31	23.60	0.06
Sigma eq	6	1.80	3	LG1	32.92	40.90	0.80
Section No 2 - Round 6.8							
Sigma Total	7	2.40	28	LG1	-29.01	40.90	0.71
Tau Total	7	0.00	37	LG1	0.77	23.60	0.03
Sigma eq	7	2.40	28	LG1	29.01	40.90	0.71
Section No 3 - Round 13							
Sigma Total	8	0.80	28	LG1	-5.00	16.10	0.31
Tau Total	8	0.00	37	LG1	0.20	9.30	0.02
Sigma eq	8	0.80	28	LG1	5.00	17.70	0.28
Section No 4 - Flat 40/3							
Sigma Total	5	0.00	1	LG1	-14.17	16.10	0.88
Tau Total	13	0.00	1	LG 4	2.89	9.30	0.31
Sigma eq	5	0.00	1	LG1	14.17	17.70	0.80
Section No 5 - Flat 30/3							
Sigma Total	1	0.00	3	LG2	10.01	16.10	0.62
Tau Total	1	0.00	1	LG4	3.91	9.30	0.42
Sigma eq	1	0.00	3	LG2	10.01	17.70	0.57

OMEGA
BRACKETS

OMEGA BRACKET (STANDARD & SERRATED) | TYPE ST- 700 1100

It is designed for fastening the natural stone panel beneath a concrete floor slab.

Horizontal Installation



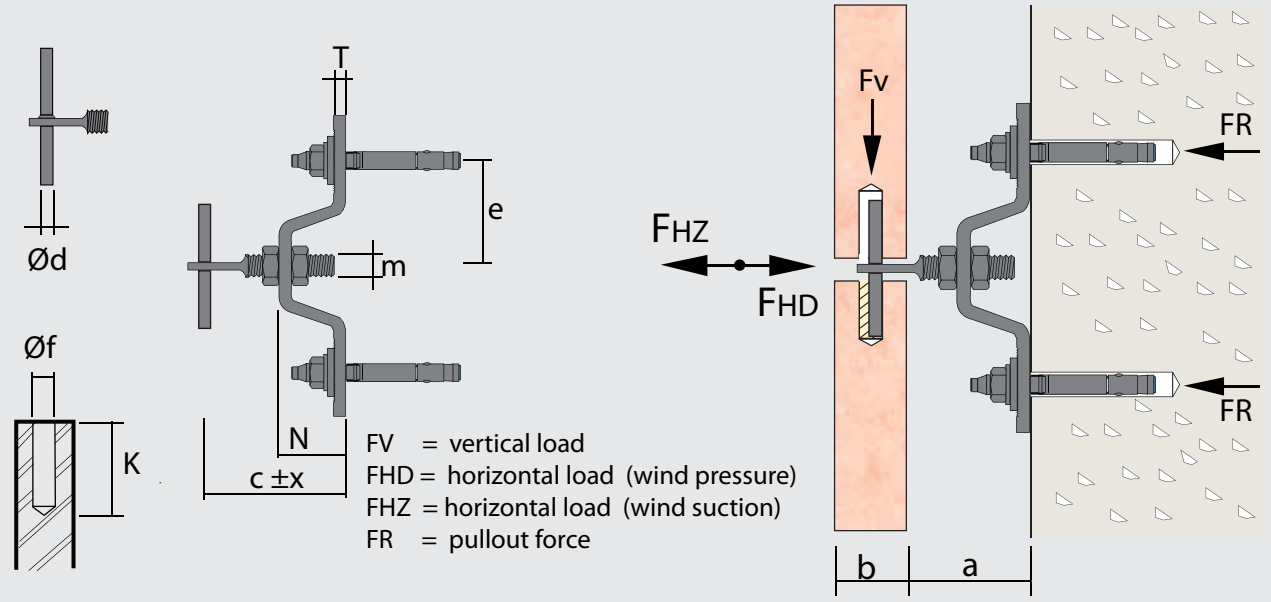
Anchoring base:
according to the anchor bolt chosen.

Adjustibility:
in 2 directions x = ± 05 mm
Z = ± 10 mm

Omega Brackets Load Table

Materials SS304, SS316, SS316L, SS316TI, S235JR-MG, S235JR-HDG ≤ 50°C 24h average temperature

Vertical Installation



Item No.	Bracket Offset (N) mm	Cavity to Pin min - max (c) mm	Dead load max DL kN	Wind load max WL ± kN	Bracket Width mm	Bracket Thickness (T) mm	Ø Pin (dz) mm	FHB A2-70 A4-70	Anchor Comb. Force kN *
700 1100-70.30.3	70	100-110	0.16	0.22	30	3	4	M8	2.30
700 1100-80.30.3	80	110-120			30	3	4	M8	2.40
700 1100-90.35.3	90	120-130			35	3	4	M8	2.50
700 1100-100.35.3	100	130-140			35	3	4	M8	2.50
700 1100-110.40.3	110	140-150			40	3	4	M8	2.50
700 1100-120.40.3	120	150-160			40	3	4	M8	2.60
700 1100-70.55.3	70	100-110	0.28	0.39	55	3	5	M10	4.10
700 1100-80.55.3	80	110-120			55	3	5	M10	4.20
700 1100-90.50.4	90	120-130			50	4	5	M10	4.30
700 1100-100.50.4	100	130-140			50	4	5	M10	4.40
700 1100-110.55.4	110	140-150			55	4	5	M10	4.50
700 1100-120.55.4	120	150-160			55	4	5	M10	4.60
700 1100-70.50.5	70	100-120	0.55	0.77	50	5	6	M12	8.80
700 1100-80.50.5	80	110-130			50	5	6	M12	9.00
700 1100-90.55.5	90	120-140			55	5	6	M12	9.20
700 1100-100.55.5	100	130-150			55	5	6	M12	9.40
700 1100-110.60.5	110	140-160			60	5	6	M12	9.60
700 1100-120.60.5	120	150-170			60	5	6	M12	9.80

Loads per 1 bracket
If loads are bigger or dimensions are different, an individual calculation is needed
* with safety 3,0

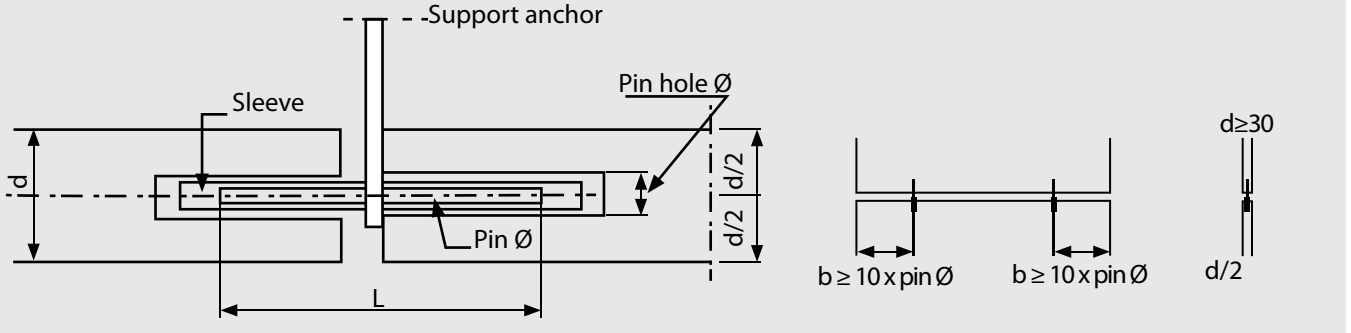
FLAT HEAD BOLT TECHNICAL DETAILS

Flat Head Bolt

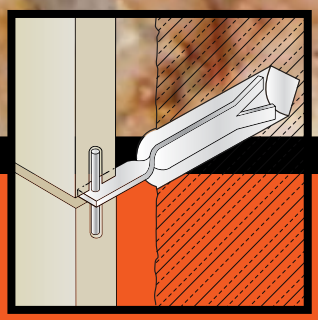
Materials A2-70, A4-70 ≤ 50°C 24h average temperature
Fixing in reinforced concrete vertical wall, or steel substructure

Cavity to Pin min - max mm	Dead load max DL kN	Wind load max WL ± kN	FHB A2-70 A4-70	Ø Pin mm
20-30	0.08	0.11	M6	4
30-40			M6	4
40-50			M8	4
50-60			M8	4
30-40	0.16	0.22	M8	4
40-50			M8	4
50-60			M10	4
60-70			M10	4
30-40	0.23	0.32	M10	5
40-50			M10	5
50-60			M10	5
60-70			M10	5
30-40	0.45	0.63	M12	6
40-50			M12	6
50-60			M12	6
60-70			M12	6

According to DIN 18515 part 3
Pins: pin hole shall be 3mm bigger than pin diameter.
Pin distances (d<30): distance between panel corner and middle pin hole is minimum 2.5 times larger than the panel thickness.



FISHTAIL
BRACKETS

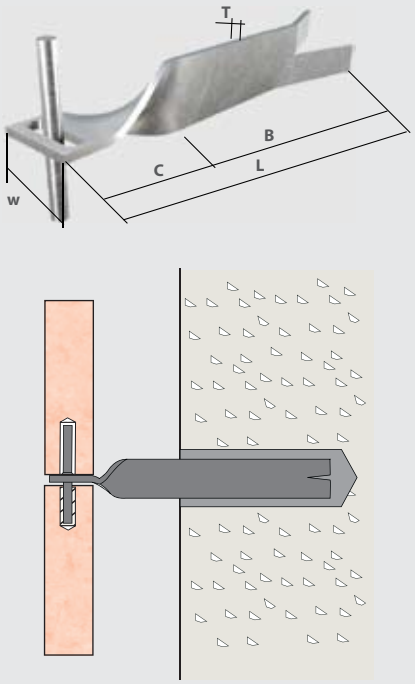


TYPE ST- 800 -1100

Fishtail with Pin | Type ST- 800 1100

Materials SS304, SS316, SS316L, SS316TI, S235JR-MG, S235JR-HDG ≤ 50°C 24h average temperature
Standard items:

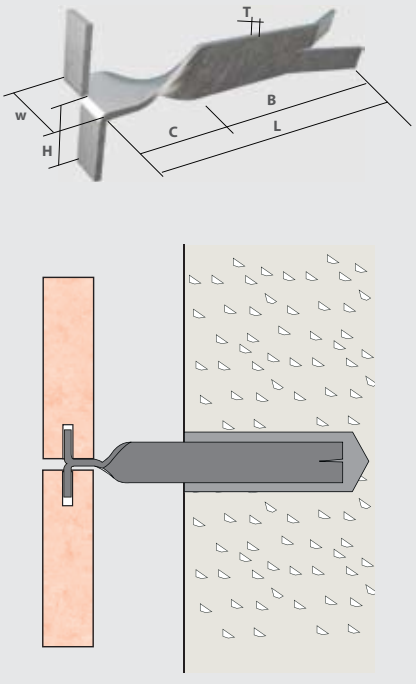
Item No.	Width (W)	Thickness (T)	Length (L)	Slot
800-1100-25.2.100	25	2	100	4.1 x 15
800-1100-25.2.120	25	2	120	4.1 x 15
800-1100-25.2.140	25	2	140	4.1 x 15
800-1100-25.2.160	25	2	160	4.1 x 15
800-1100-25.3.100	25	3	100	4.1 x 15
800-1100-25.3.120	25	3	120	4.1 x 15
800-1100-25.3.140	25	3	140	4.1 x 15
800-1100-25.3.160	25	3	160	4.1 x 15
800-1100-30.4.100	30	4	100	5.1 x 15
800-1100-30.4.120	30	4	120	5.1 x 15
800-1100-30.4.140	30	4	140	5.1 x 15
800-1100-30.4.160	30	4	160	5.1 x 15



Fishtail Up & Down | Type ST- 800 1200

Materials SS304, SS316, SS316L, SS316TI, S235JR-MG, S235JR-HDG ≤ 50°C 24h average temperature
Standard items:

Item No.	Width (W)	Thickness (T)	Length (L)	Height (H)
800-1200-25.2.100	25	2	100	15
800-1200-25.2.120	25	2	120	15
800-1200-25.2.140	25	2	140	15
800-1200-25.2.160	25	2	160	15
800-1200-25.3.100	25	3	100	15
800-1200-25.3.120	25	3	120	15
800-1200-25.3.140	25	3	140	15
800-1200-25.3.160	25	3	160	15
800-1200-30.4.100	30	4	100	15
800-1200-30.4.120	30	4	120	15
800-1200-30.4.140	30	4	140	15
800-1200-30.4.160	30	4	160	15



TYPE ST- 800 -1200

Fishtail (Pin & Up and Down) ST- 800 (1100-1200)

Materials SS304, SS316, SS316L, SS316TI, S235JR-MG, S235JR-HDG ≤ 50°C 24h average temperature.
Fixing in reinforced concrete vertical wall

Cavity to Pin min - max mm	Dead load max DL kN	Wind load max WL ± kN	Bracket Width mm	Bracket Thickness mm	Ø Pin A-70 mm	Embedment mm	Length mm
40-50	0.10	0.14	25	2	4	45	100
50-60			25	2	4	55	120
60-70			25	2	4	65	140
70-80			25	2	4	75	160
40-50	0.22	0.31	25	3	4	45	100
50-60			25	3	4	55	120
60-70			25	3	4	65	140
70-80			25	3	4	75	160
40-50	0.29	0.41	30	4	5	45	100
50-60			30	4	5	55	120
60-70			30	4	5	65	140
70-80			30	4	5	75	160

Loads per 1 bracket
If loads are bigger or dimensions are different, individual calculation is needed

Fishtail (Pin & Up and Down) ST- 800 (1100-1200)

Materials SS304, SS316, SS316L, SS316TI, S235JR-MG, S235JR-HDG ≤ 50°C 24h average temperature.
Fixing in solid blockwork vertical wall

Cavity to Pin min - max mm	Dead load max DL kN	Wind load max WL ± kN	Bracket Width mm	Bracket Thickness mm	Ø Pin A-70 mm	Embedment mm	Length mm
40-50	0.08	0.11	25	2	4	45	100
50-60			25	2	4	55	120
60-70			25	2	4	65	140
70-80			25	2	4	75	160
40-50	0.13	0.18	25	3	4	45	100
50-60			25	3	4	55	120
60-70			25	3	4	65	140
70-80			25	3	4	75	160
40-50	0.20	0.28	30	4	5	45	100
50-60			30	4	5	55	120
60-70			30	4	5	65	140
70-80			30	4	5	75	160

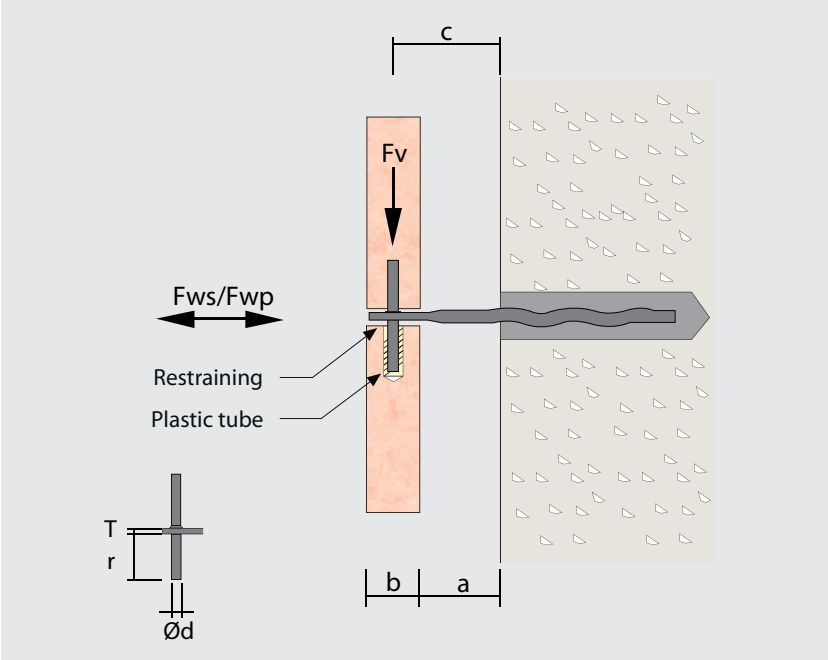
Loads per 1 bracket
If loads are bigger or dimensions are different, individual calculation is needed

CORRUGATED DOWEL

TYPE ST- 900 -1100 (CORRUGATED DOWEL)

Corrugated Dowel | ST- 900 1100

The mortar anchor is a restraint anchor and is used to install the last row of slabs on to concrete and masonry walls at horizontal installation. This anchor can be used for wind loads of up to 1000 N and can be used on projection, in addition it can be used both in horizontal and vertical joints.
Load bearing and restraining corrugated stud.
Material: SS304, SS316, SS316L, SS316TI, S235JR-MG, S235JR-HDG

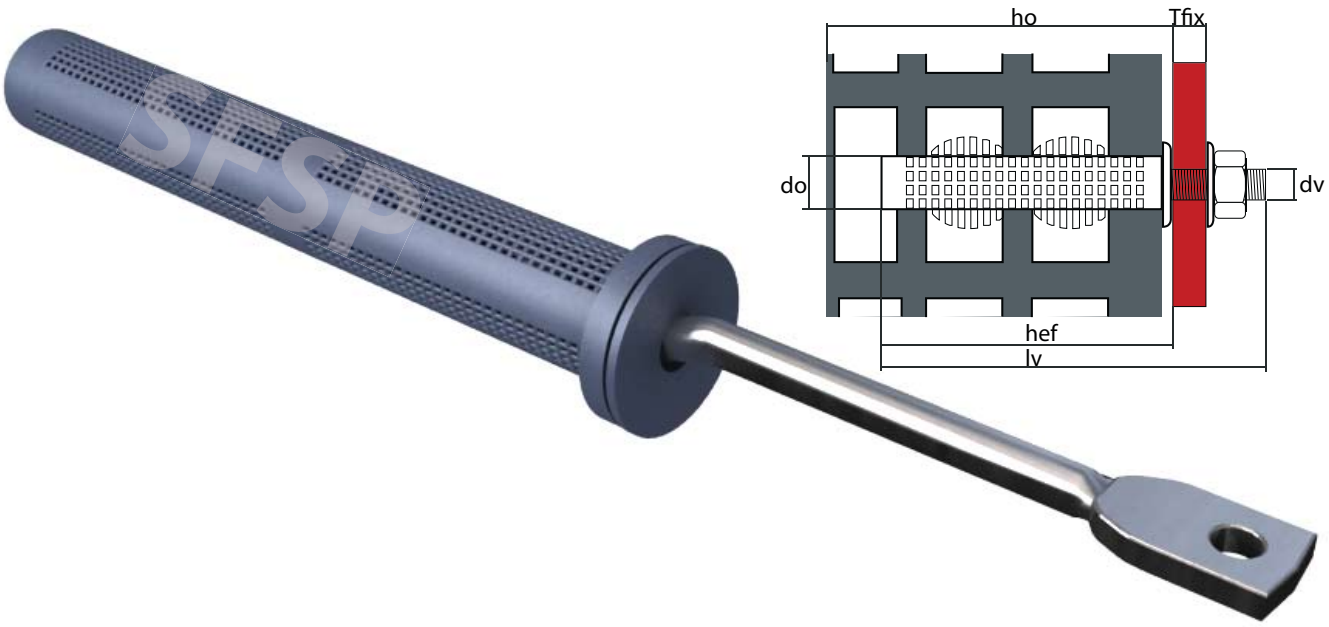


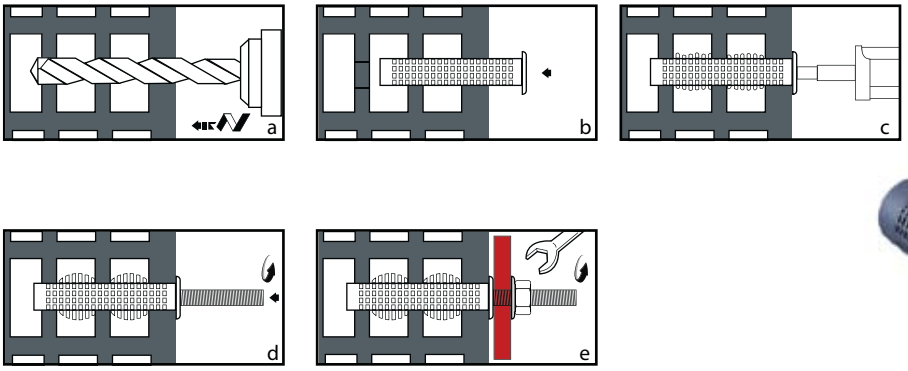
Corrugated Dowel | ST- 900 1100

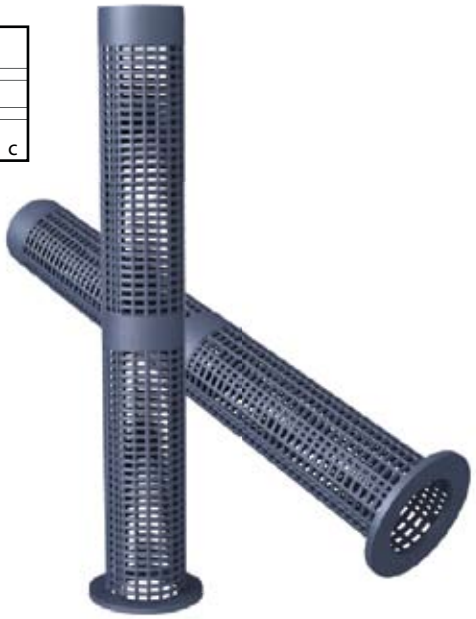
Load-bearing and retaining angles.
Material: SS304, SS316, SS316L, SS316TI, S235JR-MG, S235JR-HDG ≤ 50°c 24h average temperature
Standard items

Net anchor	Code	ø Stud	Stud length /EHD	ø Hole	ø Inside	Hole depth	Fixable thickness /EHD	Hole volume	Resin volume to inject
Type	Code	dv/mm	l/mm	do/mm	dv/mm	ho/mm	tfix/mm	cm^3	cm^3
BE 12x45	8708955	M6-M8	65	12	10	45	-	5.1	5.1
BE 12x60	8708956	M6-M8	80	12	10	60	-	6.8	6.8
BE 12x80	8708957	M6-M8	110	12	10	70	10	9.1	9.1
BE 15x85	8708952	M8-M10	110-160	15	13	85	30-55	15.0	15.0
BE 15x130	8708953	M8-M10	160	15	13	130	10	23.0	23.0
BE 20x85	8708954	M12	115	20	18	85	10	26.7	26.7
BM 11x1000	8708961	M8	var.	12	9.5	var.	-	-	-
BM 15x1000	8708962	M10	var.	16	13.5	var.	-	-	-
BM 20x1000	8708963	M12	var.	22	19.0	var.	-	-	-

Angles of different dimensions can be manufactured upon specific demand.







a- Drill to the suggested diameter.
b- Insert tube screen.
c- Inject the resin with the special nozzle.
d- Insert the threaded stud while turning it slowly.
e- After the cure time, fix the object.

Net anchor	Code	Ø Stud	Stud length/EHD	Ø Hole	Ø Inside	Hole depth	Fixable Thickness/EHD	Hole volume	Resin volume to inject
Type	Code	dv/mm	l/mm	do/mm	dv/mm	ho/mm	tfix/mm	cm^3	cm^3
BE 12x45	8708955	M6-M8	65	12	10	45	-	5.1	5.1
BE 12x60	8708956	M6-M8	80	12	10	60	-	6.8	6.8
BE 12x80	8708957	M6-M8	110	12	10	70	10	9.1	9.1
BE 15x85	8708952	M8-M10	110-160	15	13	85	30-55	15.0	15.0
BE 15x130	8708953	M8-M10	160	15	13	130	10	23.0	23.0
BE 20x85	8708954	M12	115	20	18	85	10	26.7	26.7
BM 11x1000	8708961	M8	var.	12	9.5	var.	-	-	-
BM 15x1000	8708962	M10	var.	16	13.5	var.	-	-	-
BM 20x1000	8708963	M12	var.	22	19.0	var.	-	-	-

Body Anchor
BRACKETS

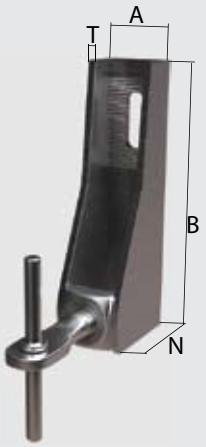
SFSP

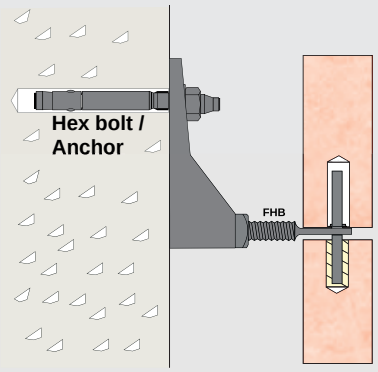
SYSTEM TYPE ST 1000 -1100

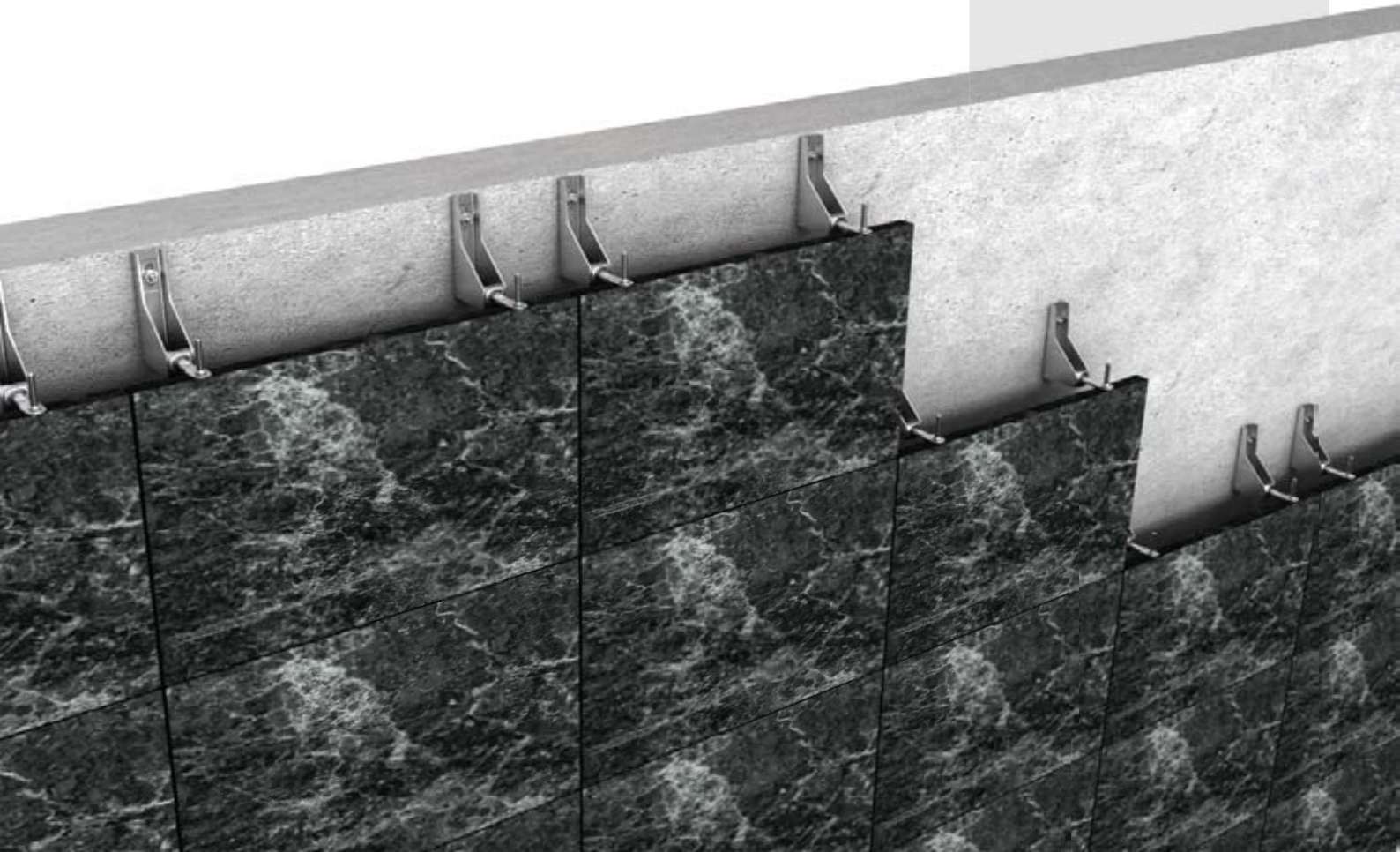
Body Anchor -Bracket (Standard & Serrated) | Type ST- 1000 1100

Materials SS304, SS316, SS316L, SS316TI, S235JR-MG, S235JR-HDG ≤ 50°C 24h average temperature
Standard items:

Item No.	T	A	B	N	Pin	Slot
1000 -1100-3	2,0	30	100	30	5x60	8,5x28
1000 -1100-5	2,0	30	100	50	5x60	8,5x28
1000 -1100-7	2,0	30	100	70	5x60	8,5x28





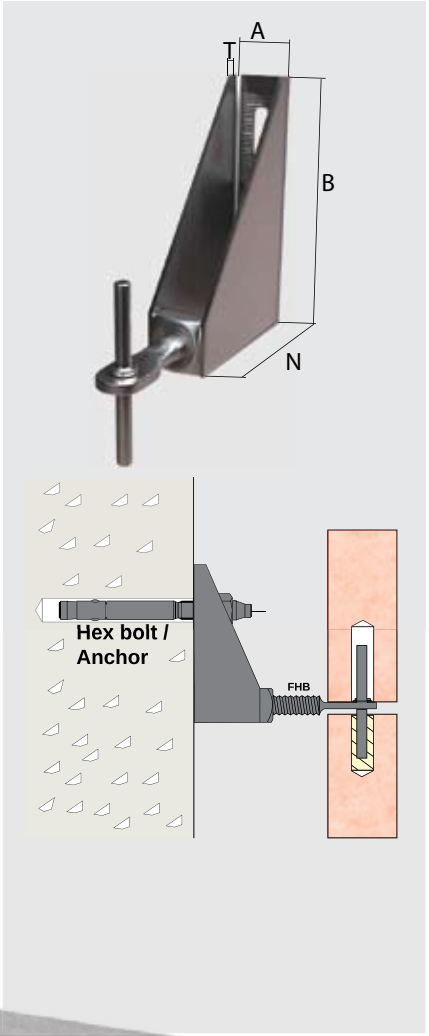


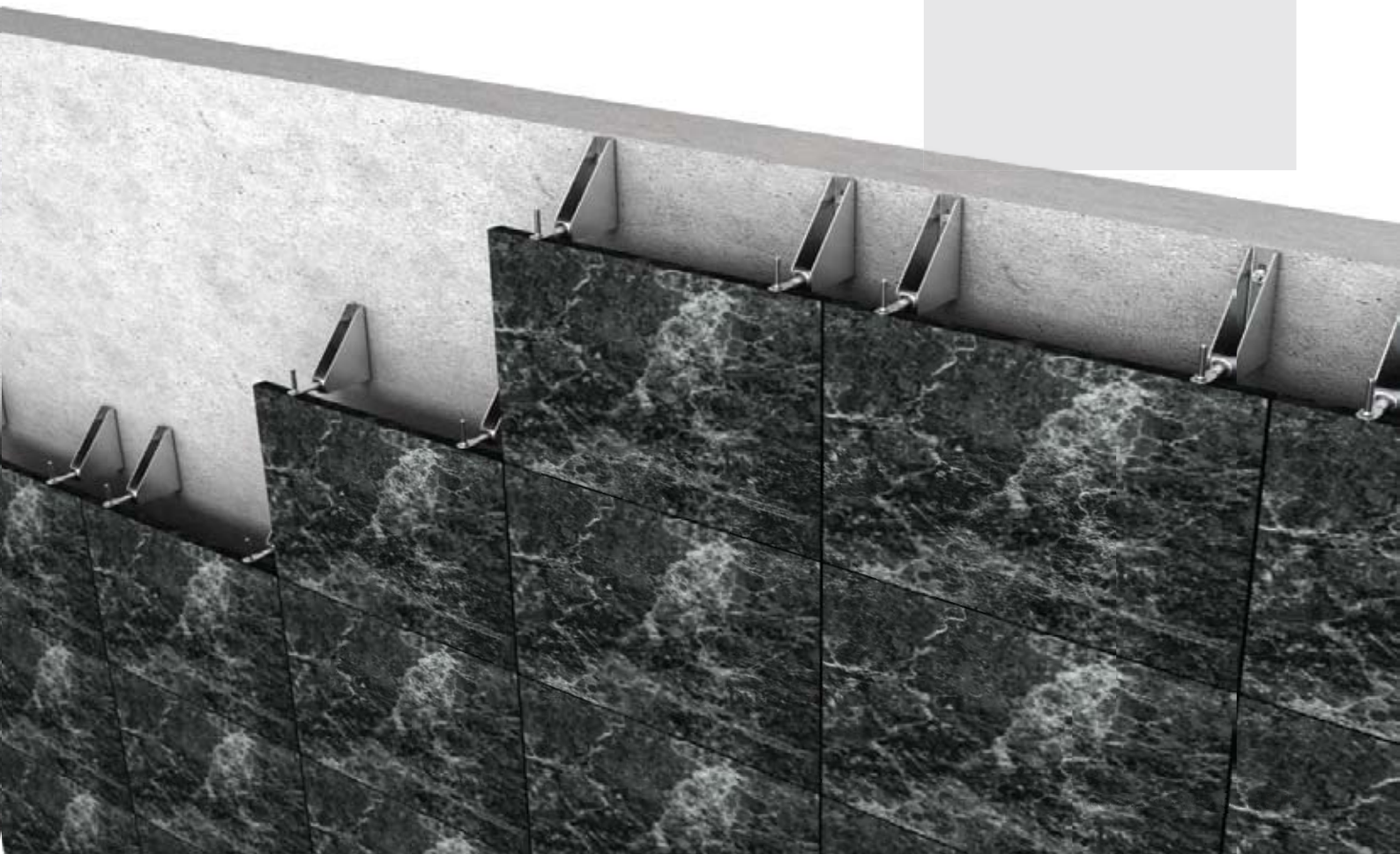
SYSTEM TYPE ST 1000 -1200

Body Anchor -Bracket (Standard & Serrated) | Type ST- 1000 1200

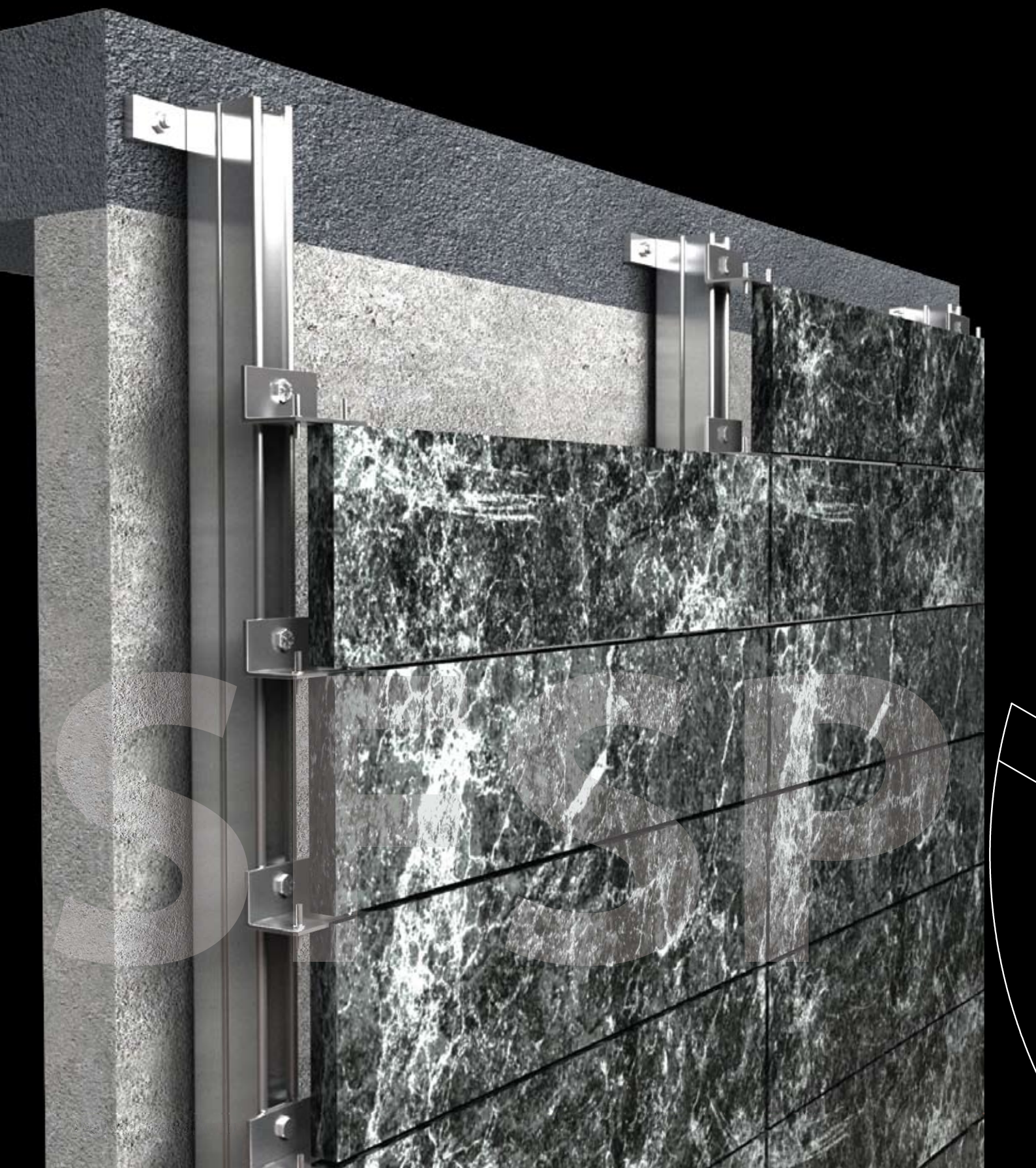
Materials SS304, SS316, SS316L, SS316TI, S235JR-MG, S235JR-HDG ≤ 50°C 24h average temperature
Standard items:

Item No.	T	A	B	N	Pin	Slot
1000 -1200-7	3,0	30	120	70	5x60	10,5x28
1000 -1200-9	3,0	30	120	90	5x60	10,5x28
1000 -1200-11	3,0	30	120	110	5x60	10,5x28
1000 -1200-13	3,0	30	120	130	5x60	10,5x28
1000 -1200-15	3,0	30	120	150	5x60	10,5x28
1000 -1200-17	3,0	30	120	170	5x60	10,5x28





STEEL
BACK SUPPORT SYSTEM



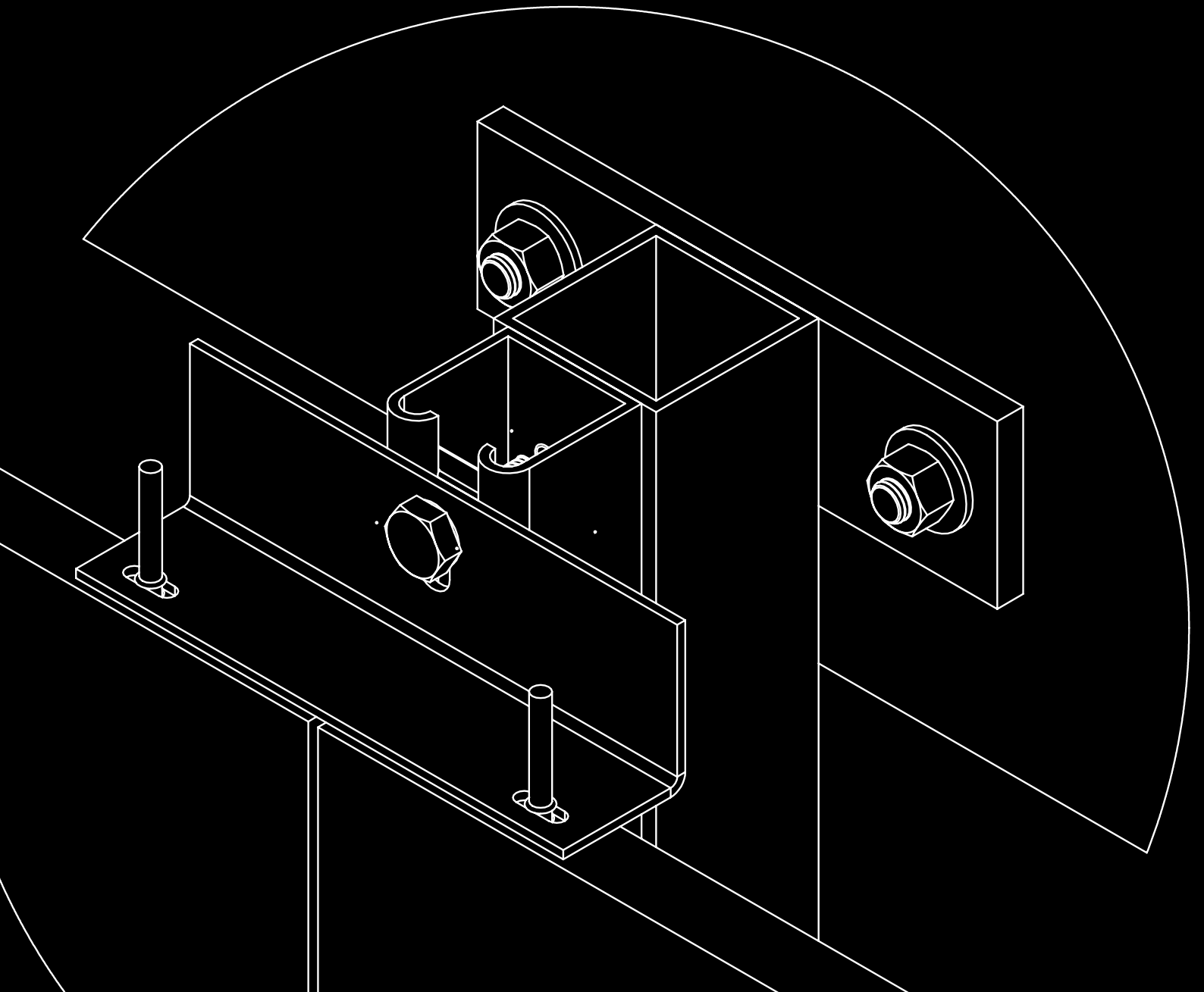
Example -1
Front To Back Channel with Welded Back Plate and Up & Down Bracket

Example -2
Square Tube with Welded Channel & Double Pin L-Bracket

Example -3
Single Channel with Omega Support and Z-Brackets

Example -4
BTB (Back to Back Channels) with Omega Support and Z-Brackets

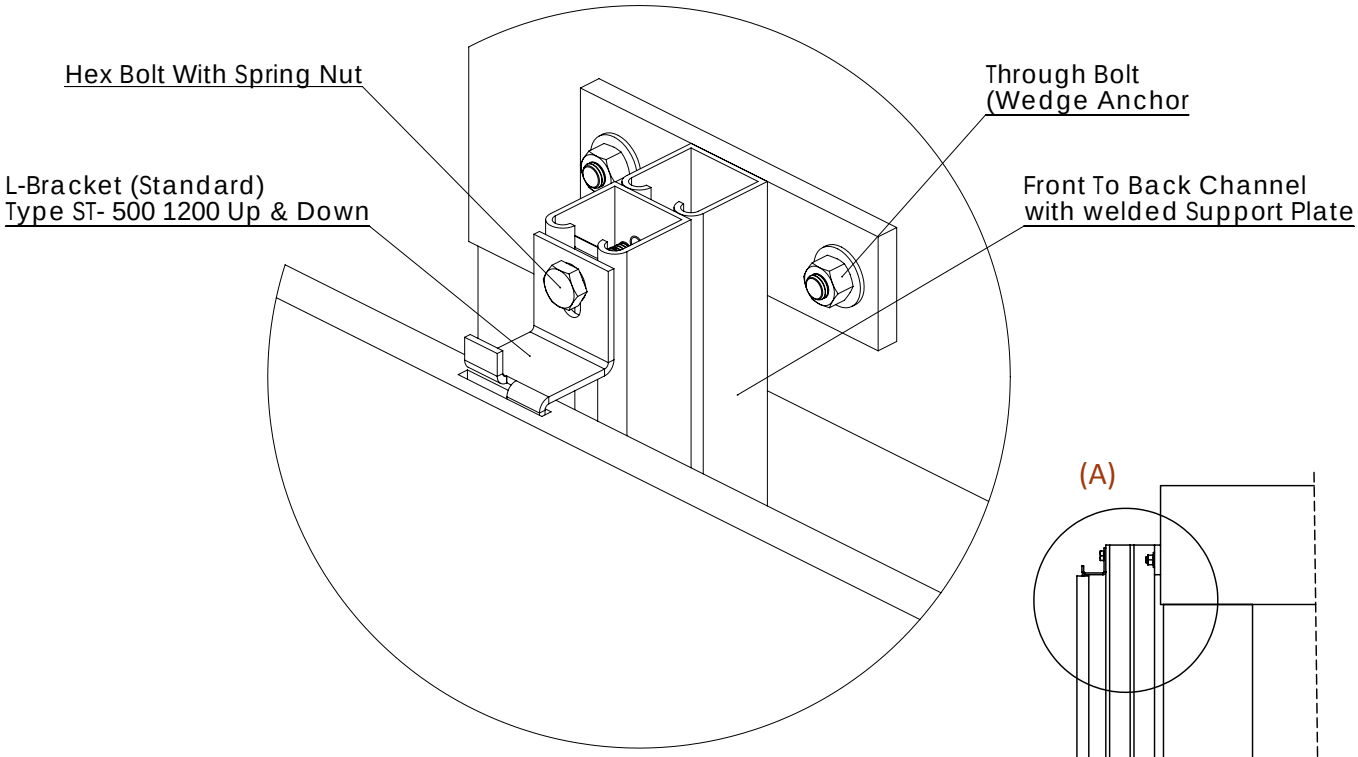
Example -5
Cantilever Arm with BTB (Back to Back Channels) and Flat Head Bolt

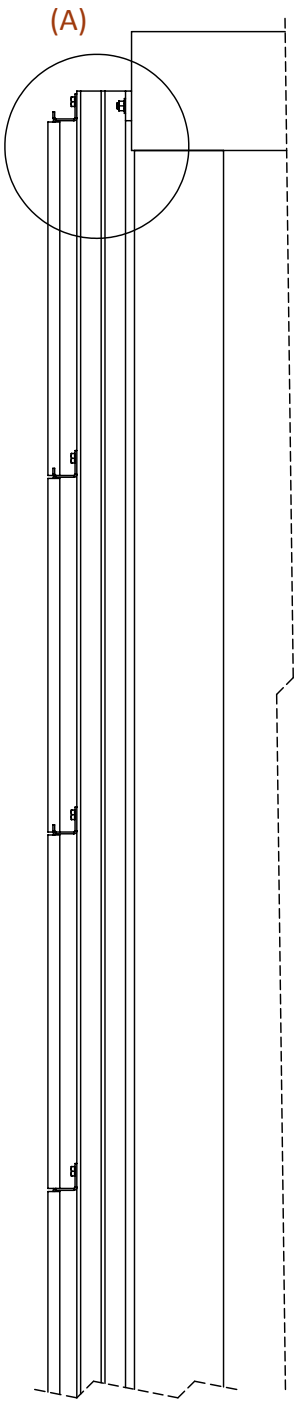


EXAMPLES OF STEEL BACK SUPPORT SYSTEMS

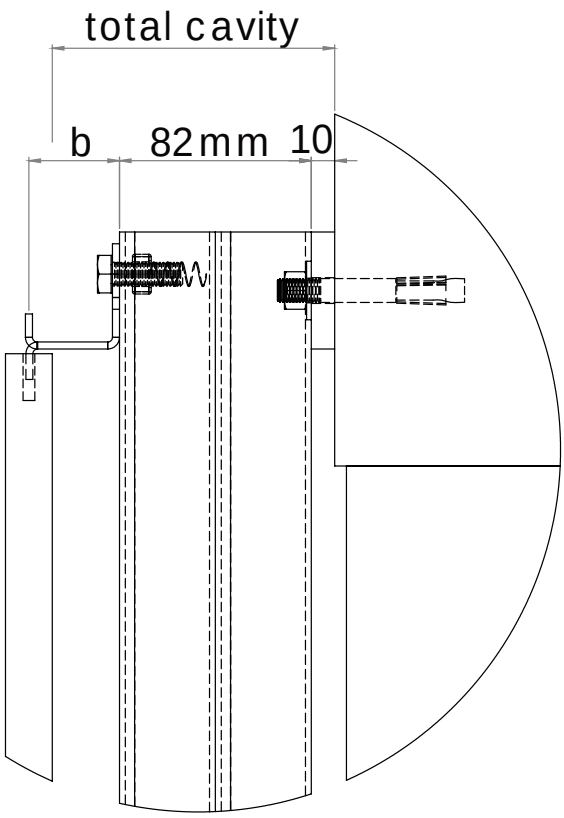
Example -1
Front to Back Channel with Welded Back Plate and Up & Down Bracket

Floor to floor system using front to back channels with support plates and L-Brackets up & down with bolts and spring nuts fixed to the channels .
- Minimum cavity to backside of panel: 100 mm
- Span ≤ 3,0 m


Hex Bolt With Spring Nut
Through Bolt
(Wedge Anchor
L-Bracket (Standard)
Type ST- 500 1200 Up & Down
Front To Back Channel
with welded Support Plate

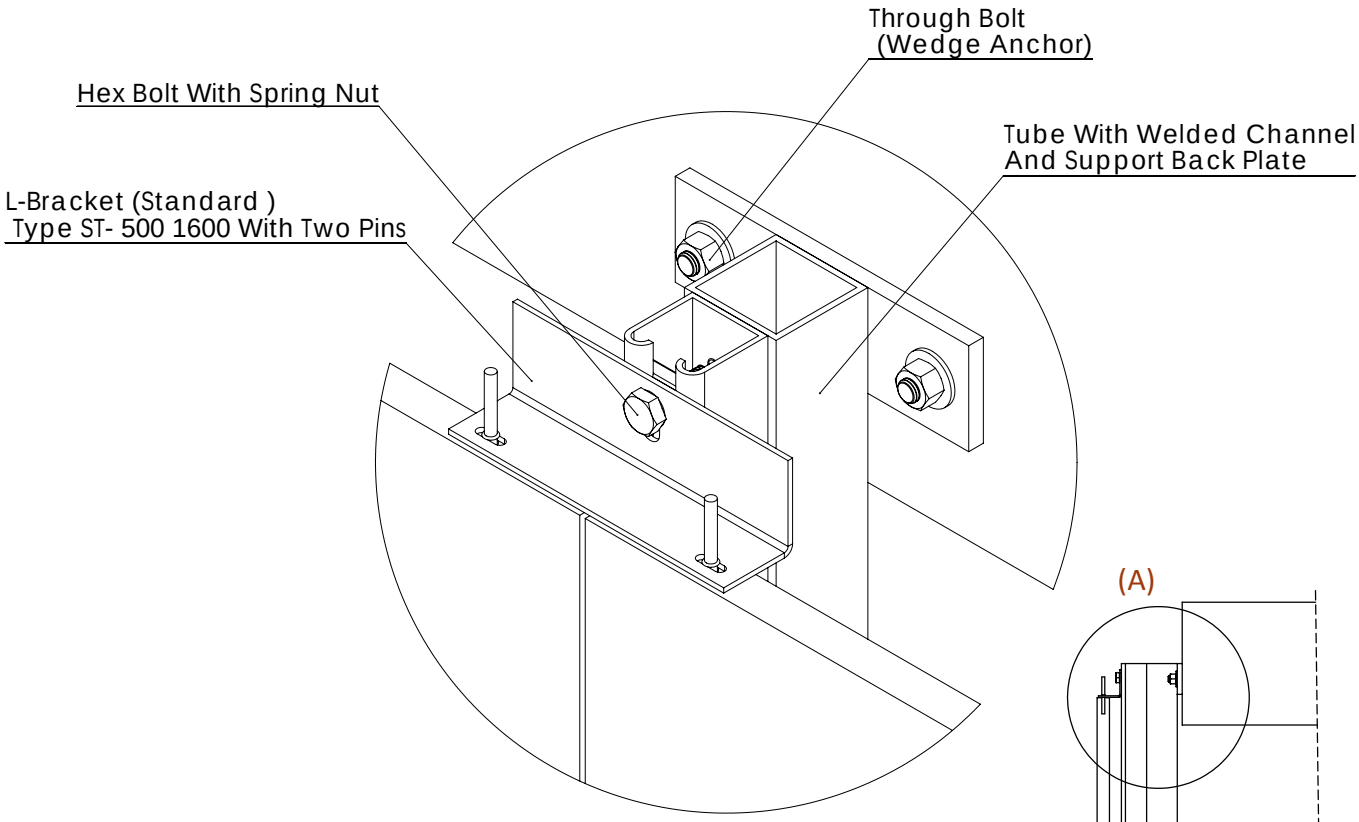

(A)

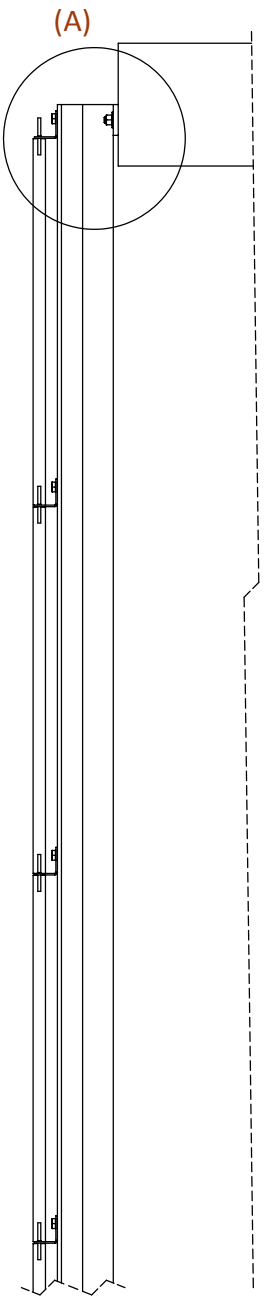
Detail (A)


total cavity
b
82mm
10

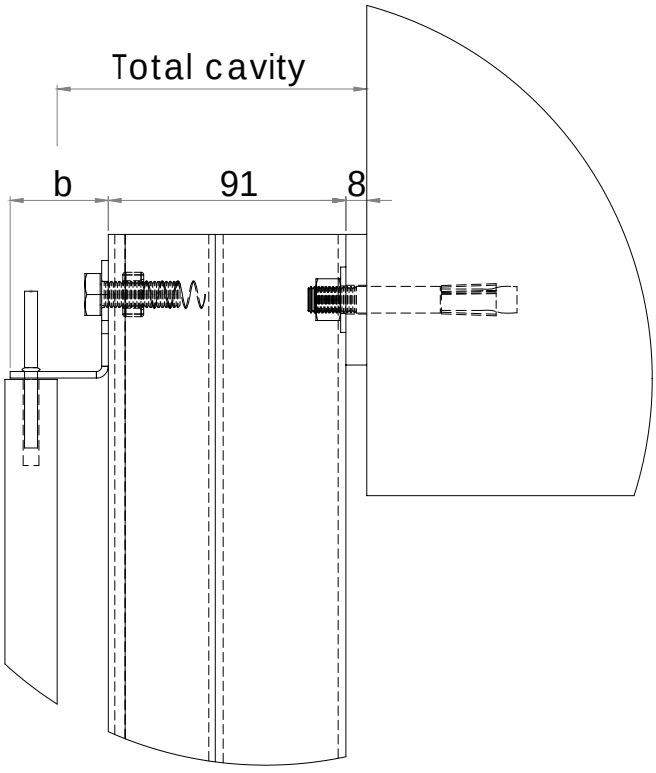
Example -2
Square Tube with Welded Channel & Double Pin L-Bracket

Floor to floor system using square tubes with channels and L-Brackets double pin type with bolts and spring nuts fixed to the channels .
- Min cavity to backside of panel: 120 mm
- Span ≥ 3,0 m


Through Bolt
(Wedge Anchor)
Hex Bolt With Spring Nut
Tube With Welded Channel
And Support Back Plate
L-Bracket (Standard)
Type ST- 500 1600 With Two Pins


(A)

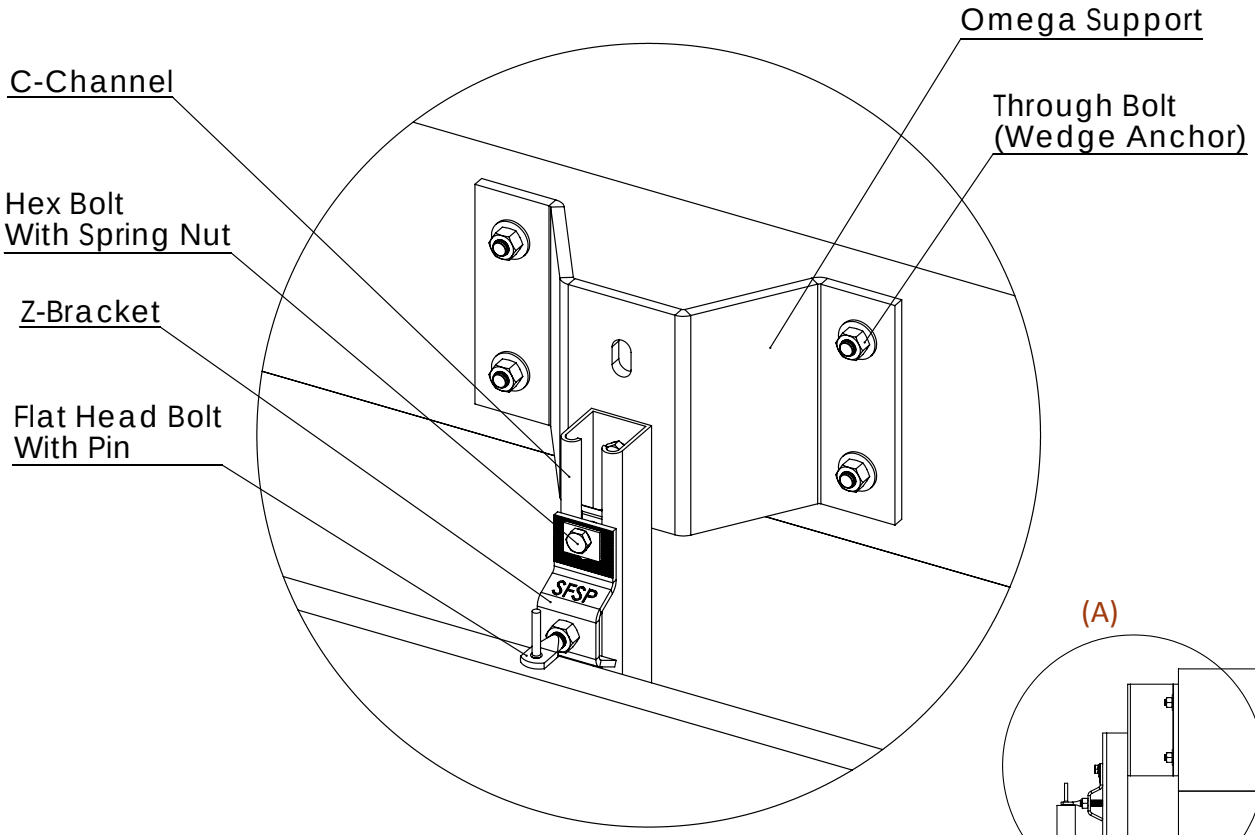
Detail (A)


Total cavity
b
91
8

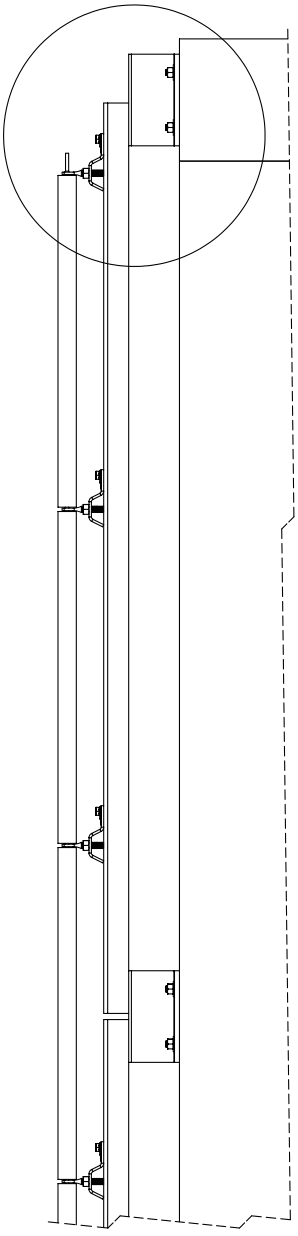
EXAMPLES OF STEEL BACK SUPPORT SYSTEMS

Example -3
Single Channel with Omega Support and Z-Brackets

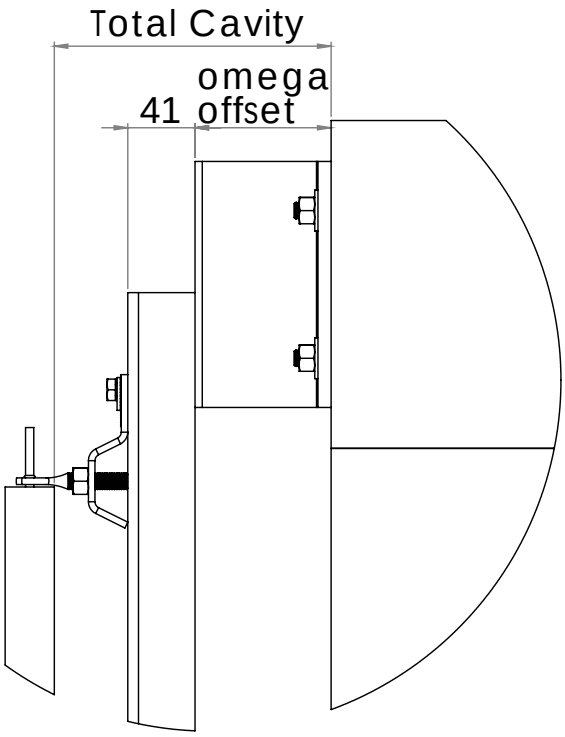
Steel back support system for large cavity using omega brackets, channels and Z- brackets with bolts and spring nuts fixed to the channels and adjustable flat head bolts .
- For cavity ≥ 150 mm
- Distance of Omega brackets ~150 cm (=Span of channels)


Omega Support
C-Channel
Through Bolt
(Wedge Anchor)
Hex Bolt
With Spring Nut
Z-Bracket
Flat Head Bolt
With Pin
SFSP

(A)



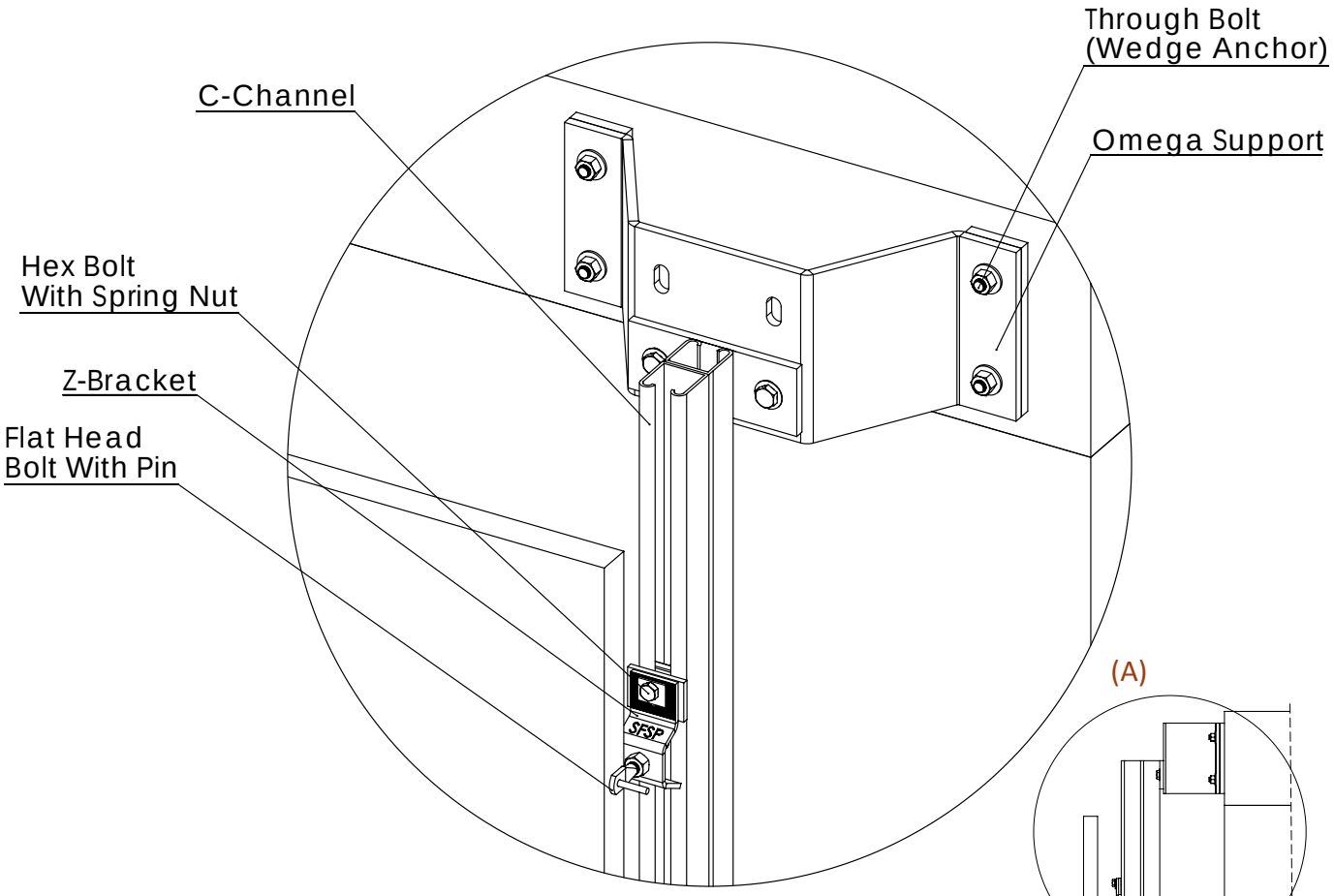
Detail (A)


Total Cavity
omega
41 offset

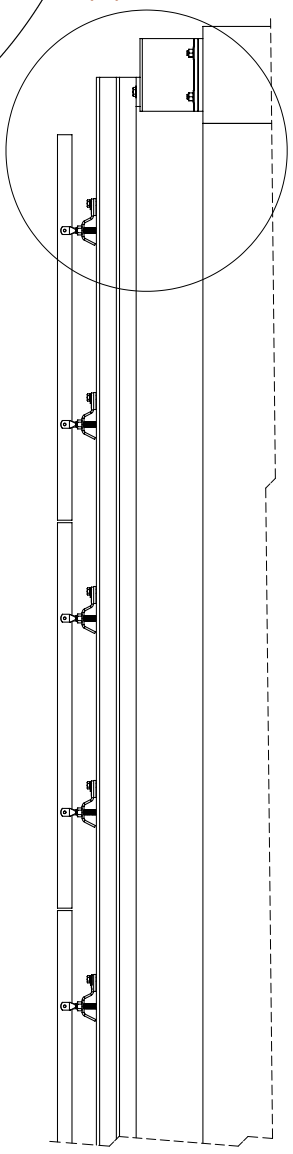
EXAMPLES OF STEEL BACK SUPPORT SYSTEMS

Example -4
BTB (Back to Back Channels) with Omega Support and Z-brackets

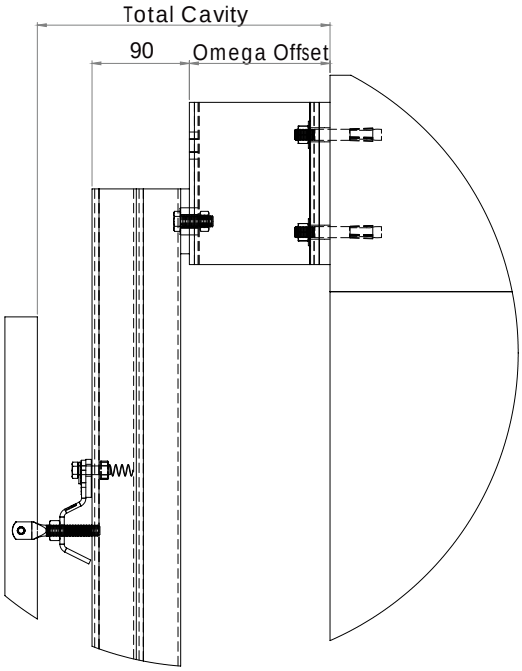
Steel back-support system for large cavity using omega brackets, channels and Z- brackets with bolts and spring nuts fixed to the channels and adjustable flat head bolts.
- For cavity ≥ 200mm
- Distance of Omega brackets ~200-300cm


Through Bolt
(Wedge Anchor)
C-Channel
Omega Support
Hex Bolt
With Spring Nut
Z-Bracket
Flat Head
Bolt With Pin
SFSP

(A)



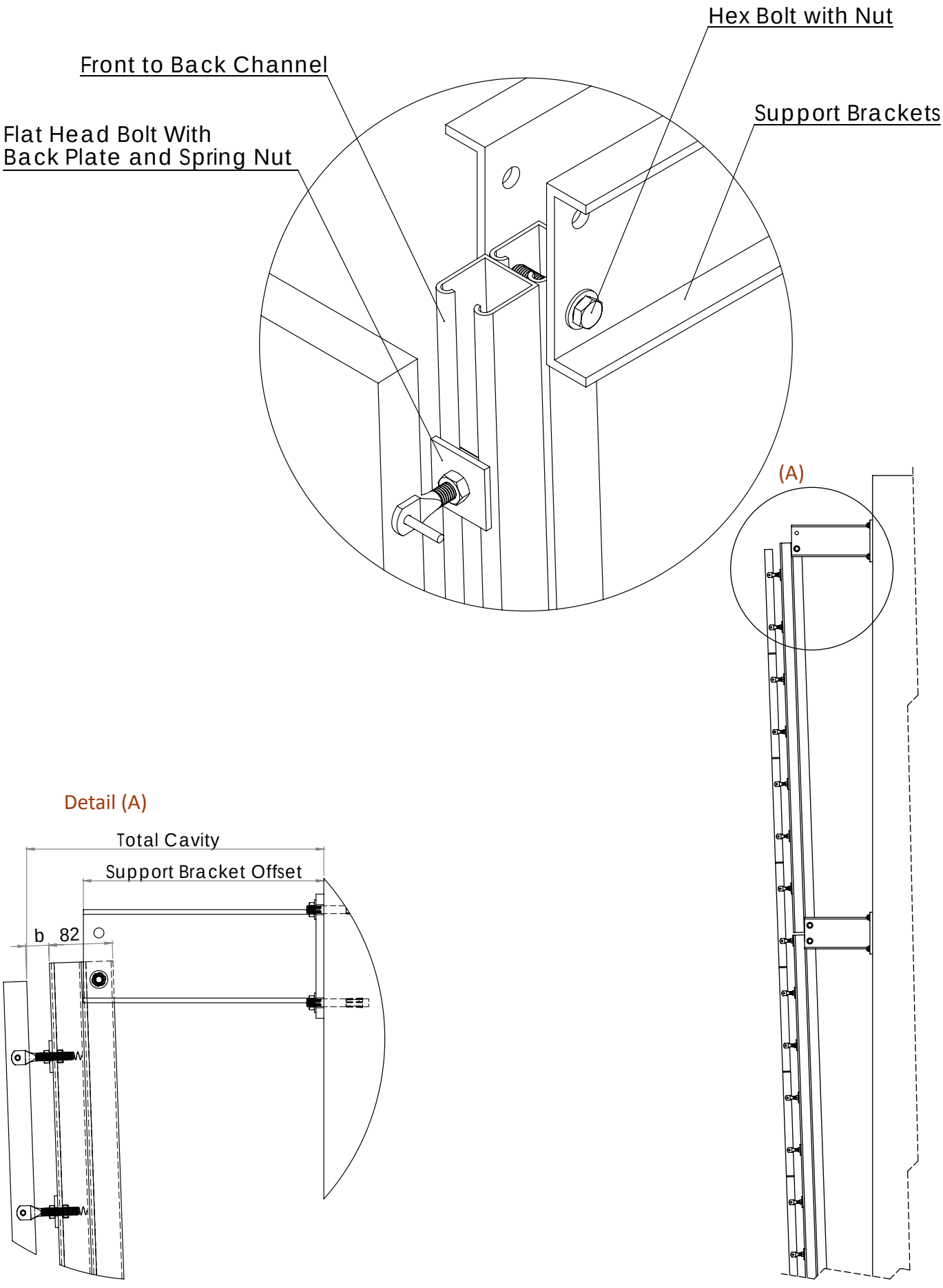
Detail (A)


Total Cavity
90
Omega Offset

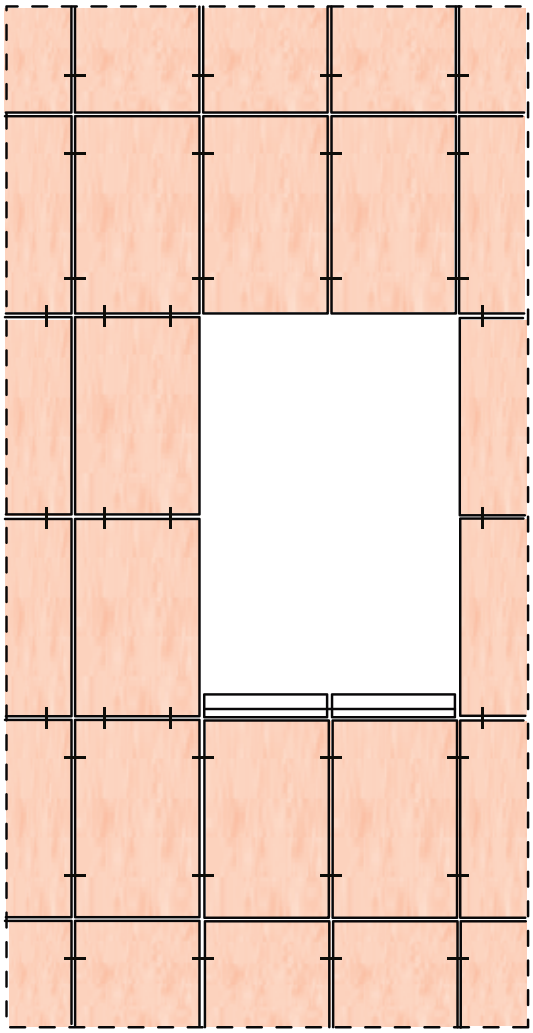
EXAMPLES OF STEEL BACK SUPPORT SYSTEMS

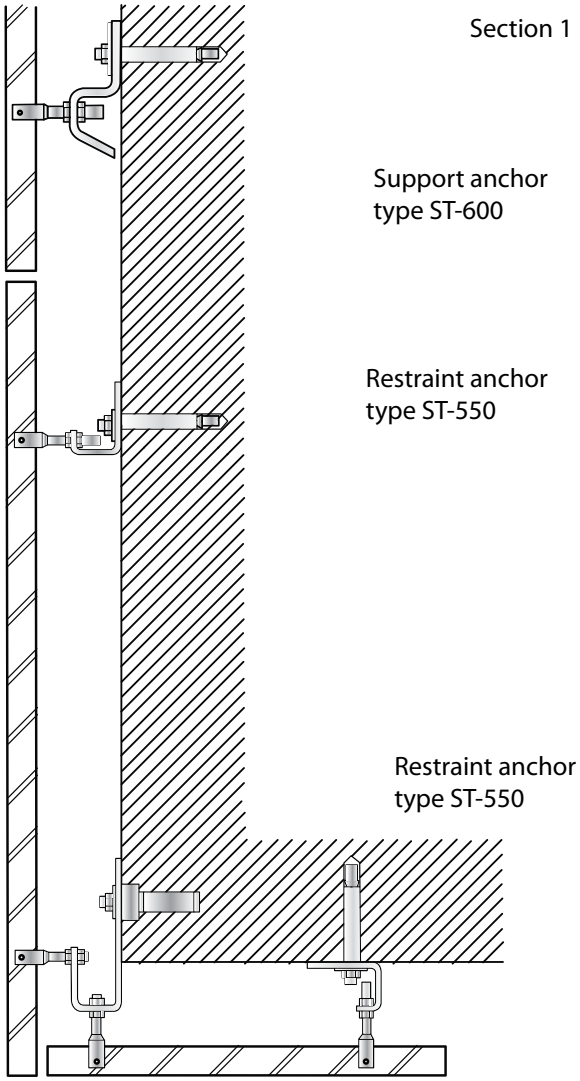
Example -5
Cantilever Arm Support with BTB (Back to Back Channels) and Flat Head Bolt

Steel back support system for adjustable large cavities using support brackets, front to back channels and adjustable flat head bolts with back plates and spring nuts fixed to channels.
- For cavity ≥ 300 mm
- Distance of Omega brackets ~3 m (=Span of channels).

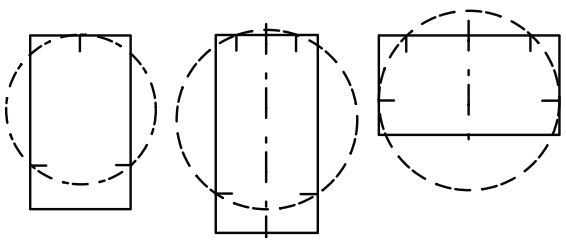

Hex Bolt with Nut
Front to Back Channel
Support Brackets
Flat Head Bolt With
Back Plate and Spring Nut
(A)
Detail (A)
Total Cavity
Support Bracket Offset
b
82

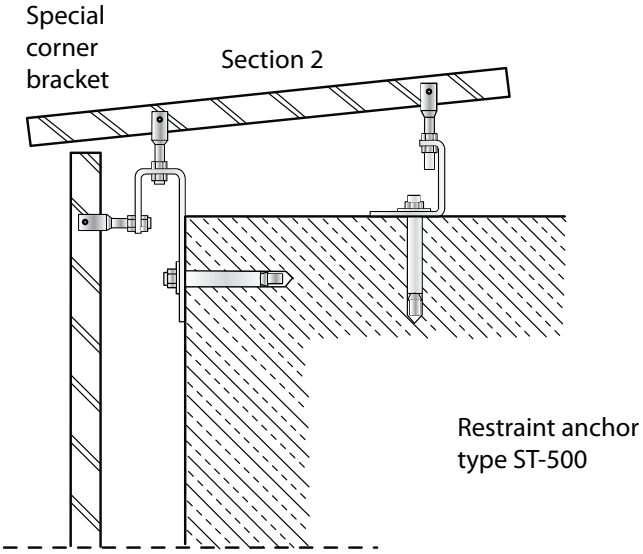
Detailed Solution: Fixing of Slabs at Openings, ex : Window

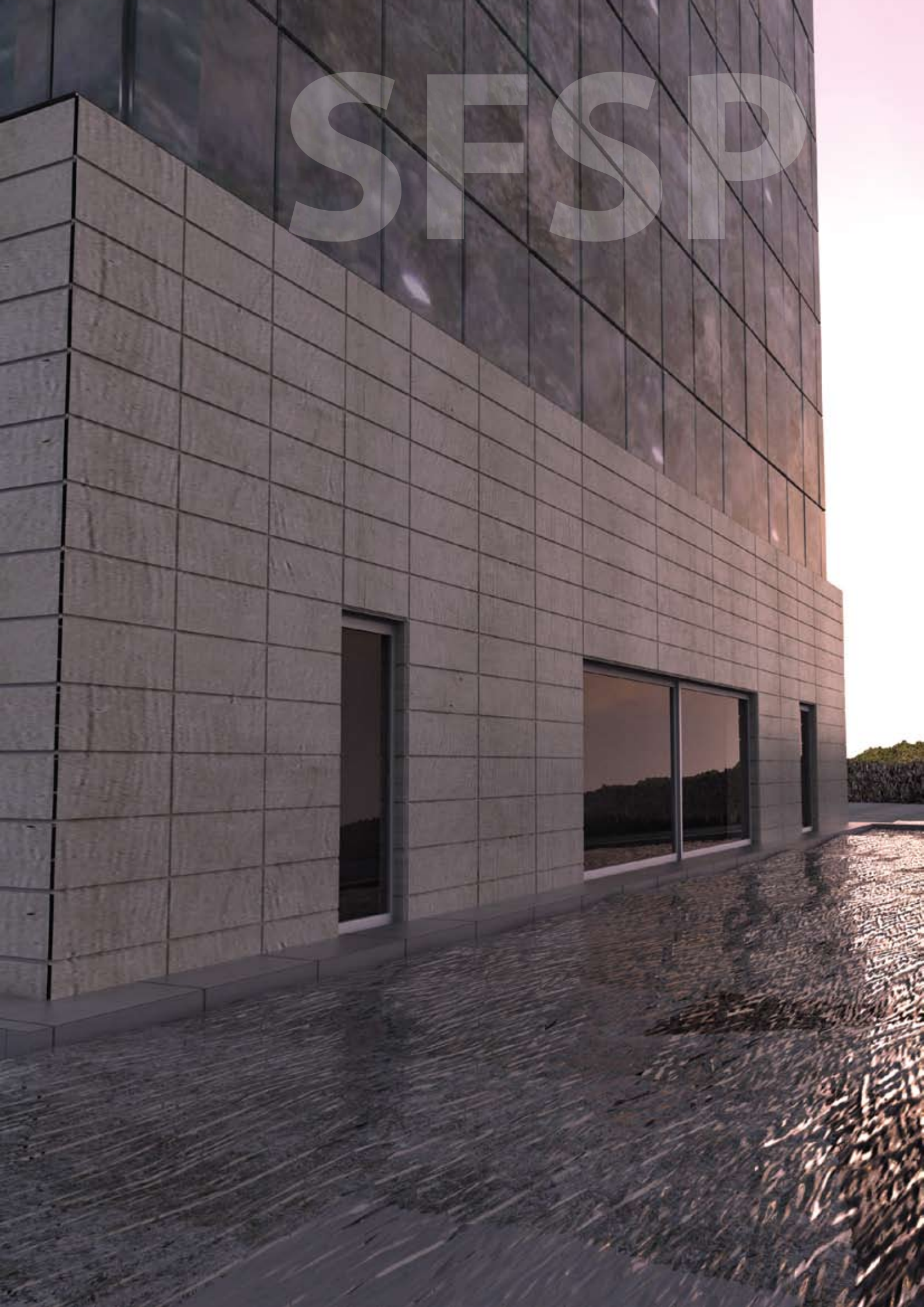




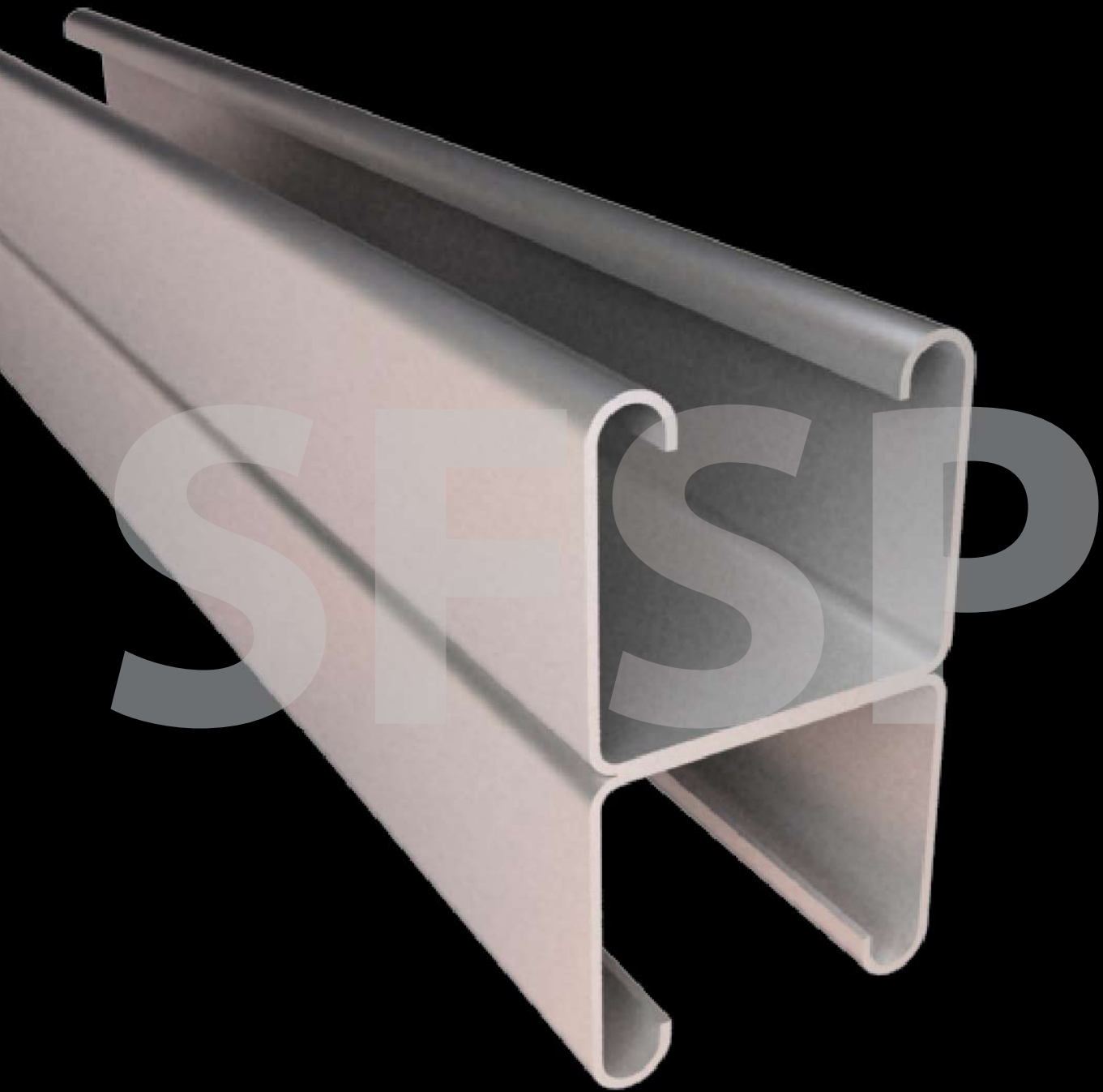
Fixings positions as per DIN 18516 part 3.
Slabs will be held usually at 3 or 4 points.
Fixings positions have to allow the slab to contract or expand freely when subject to temperature variance.
All fixing points have to be located on an imaginary circle if drawn through these points.

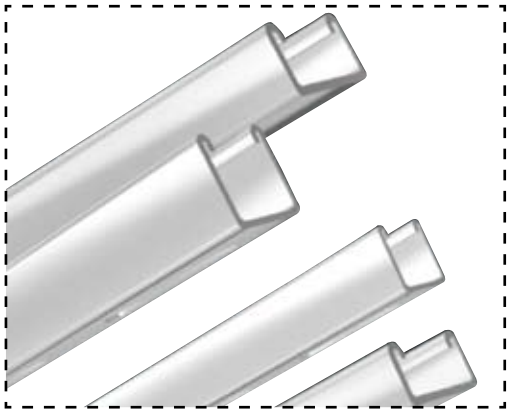





SFSP

C-CHANNELS
LOAD AND SUPPORT





Channel

SFSP's metal framing channel is cold formed on modern rolling machines from low carbon steel manufactured according to BS 6946:1988. A continuous slot provides the ability to make attachments at any point.

Lengths

Standard length: 3000mm with ± 3.2mm length tolerance.
Custom lengths are available upon request.

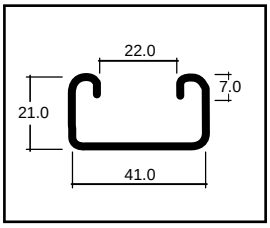
Finishes

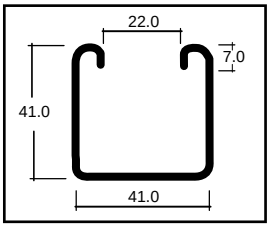
Standard finishes: Pre-Galvanized finish (ASTM A653M coating G90 and G60). Hot-Dip Galvanized after fabrication (ASTM A123 or BSEN ISO1461:2005) . Other custom coatings are available upon request.

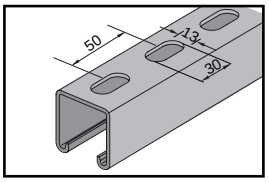
METAL FRAMING CHANNELS

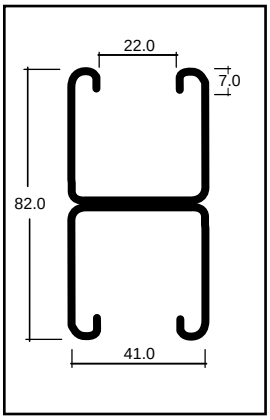
Selection Chart

Part No	Channel Dimensions		Thickness
	Height "H"	Width "W"	
CCH - 220/221	21.0 mm	41.0 mm	1.5 mm
CCH - 240/241	41.0 mm	41.0 mm	1.5 mm
CCH - 320/321	21.0 mm	41.0 mm	2.0 mm
CCH - 340/341	41.0 mm	41.0 mm	2.0 mm
CCH - 420/421	21.0 mm	41.0 mm	2.5 mm
CCH - 440/441	41.0 mm	41.0 mm	2.5 mm







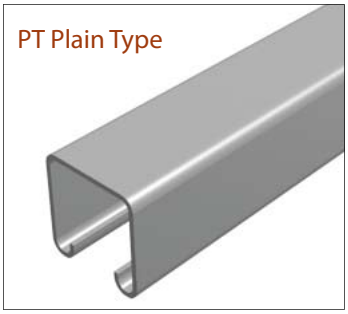


CCH 320 **3** **2** **0**

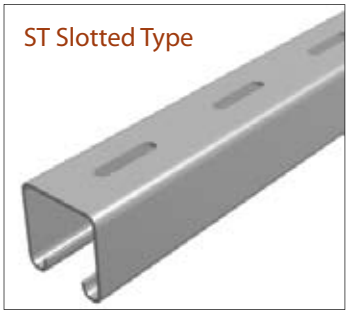
- **3** — Material Thickness
  - 2 for 1.5 mm
  - 3 for 2.0 mm
  - 4 for 2.5 mm
- **2** — Size
  - 2 - 21/41 mm
  - 4 - 41/41 mm
- **0** — Channel Patterns
  - 0 - PT
  - 1 - ST
  - 2 - BTB

CHANNEL HOLE PATTERNS

PT Plain Type



ST Slotted Type



BTB Type

PT Type Channel

Part No	Thickness mm.	Height "H"
CCH-220	1.5	21.0
CCH-240	1.5	41.0
CCH-320	2.0	21.0
CCH-340	2.0	41.0
CCH-420	2.5	21.0
CCH-440	2.5	41.0

ST Type Channel

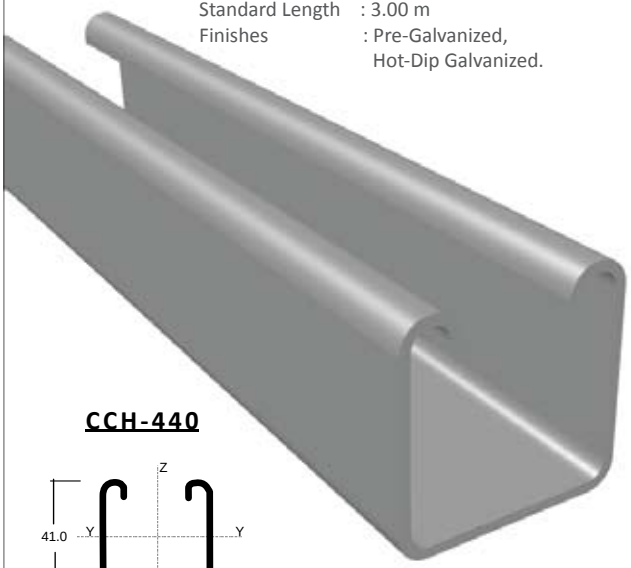
Part No	Thickness mm.	Height "H"
CCH-221	1.5	21.0
CCH-241	1.5	41.0
CCH-321	2.0	21.0
CCH-341	2.0	41.0
CCH-421	2.5	21.0
CCH-441	2.5	41.0

BTB Type Channel

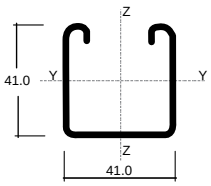
Part No	Thickness mm.	Height "H"
CCH-222	1.5	42.0
CCH-242	1.5	82.0
CCH-322	2.0	42.0
CCH-342	2.0	82.0
CCH-422	2.5	42.0
CCH-442	2.5	82.0

Load table for Single Beam with Uniform (Characteristic) Live-Load According to DIN 18.800

Thickness : 2.5 mm
Standard Length : 3.00 m
Finishes : Pre-Galvanized, Hot-Dip Galvanized.



CCH-440



C-Channel:	41x41x2.5	
Area of Shear (A_z)	1.67	cm^2
Moment of Inertia (I_y)	5.87	cm^4
Moment of Inertia (I_z)	8.76	cm^4
Min. Section Modulus (S_y)	2.72	cm^3
Warping Constant (I_w)	171.52	cm^6
Torsional Constant (I_T)	0.07	cm^4
Plastic Moment Cap. ($M_{pl,y}$)	0.82	kNm
Self Weight (G)	2.32	kg/m

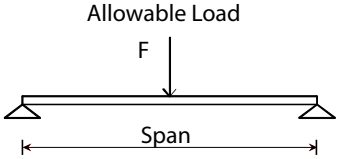
Chosen Material:	40 B = S 235 JRG2	
Allowable Bending Stress	21,82	kN/cm^2
Allowable Shear Stress	12,60	kN/cm^2
Modulus of Elasticity	21.000	kN/cm^2

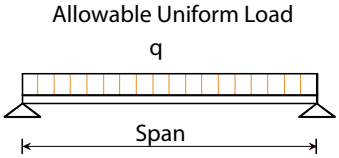
CCH-440/441

Beam Load Data

					Uniform Load* @	
Span (L)	Allowable Load*		Deflection		L / 360	L / 180
[cm]	q [kN/m]	F [kN]	U [mm]	[L /X]	q [kN/m]	q [kN/m]
50	10.10	2.50	0.83	600	10.10	10.10
60	7.00	2.10	1.20	500	7.00	7.00
70	5.20	1.80	1.65	420	5.20	5.20
80	4.00	1.60	2.16	370	4.00	4.00
90	3.10	1.40	2.69	340	2.90	3.10
100	2.50	1.30	3.30	300	2.10	2.50
125	1.60	1.00	5.16	240	1.10	1.60
150	1.10	0.80	7.35	200	0.60	1.10
175	0.80	0.70	9.91	180	0.40	0.80
200	0.63	0.60	13.31	150	0.30	0.50
225	0.50	0.60	16.92	130	0.20	0.40
250	0.41	0.50	21.15	120	x	0.30
275	0.33	0.50	24.92	110	x	0.20
300	0.28	0.40	29.95	100	x	x

* Given loads are always “allowable characteristic live load”





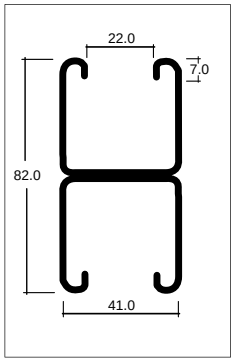
CCH-442

C-Channel:	41x41x2.5 btb	
Area of Shear (A_z)	2.37	cm^2
Moment of Inertia (I_y)	34.08	cm^4
Moment of Inertia (I_z)	17.56	cm^4
Min. Section Modulus (S_y)	8.31	cm^3
Warping Constant (I_w)	140.95	cm^6
Torsional Constant (I_T)	0.16	cm^4
Plastic Moment Cap. ($M_{pl,y}$)	2.51	kNm
Self Weight (G)	4.70	kg/m

Chosen Material:	40 B = S 235 JRG2	
Allowable Bending Stress	21.82	kN/cm^2
Allowable Shear Stress	12.60	kN/cm^2
Modulus of Elasticity	21.000	kN/cm^2

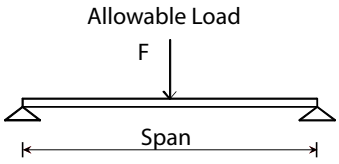
Thickness : 2.5 mm
Standard Length : 3.00 m
Finishes : Pre-Galvanized,
Hot-Dip Galvanized.

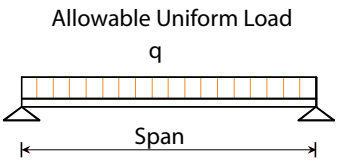
CCH-442



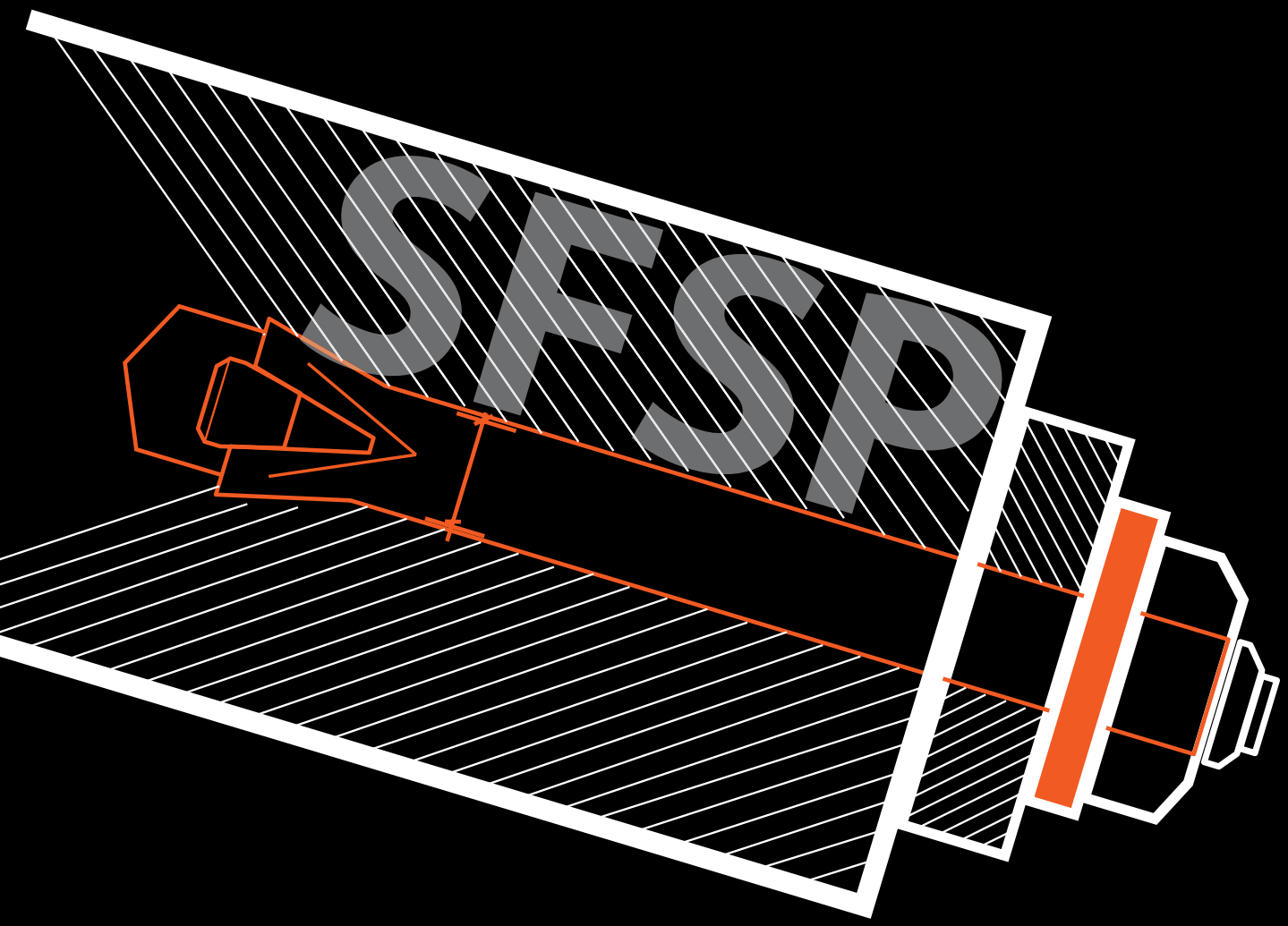
Beam Load Data

					Uniform Load* @	
Span (L)	Allowable Load*		Deflection		L / 360	L / 180
[cm]	q [kN/m]	F [kN]	U [mm]	[L /X]	q [kN/m]	q [kN/m]
50	30.90	7.70	0.44	1.140	30.90	30.90
60	21.50	6.50	0.63	950	21.50	21.50
70	15.80	5.50	0.86	810	15.80	15.80
80	12.10	4.80	1.13	710	12.10	12.10
90	9.60	4.30	1.43	630	9.60	9.60
100	7.70	3.90	1.75	570	7.70	7.70
125	5.00	3.10	2.78	450	5.00	5.00
150	3.40	2.60	3.91	380	3.40	3.40
175	2.50	2.20	5.33	330	2.30	2.50
200	1.90	1.90	6.91	290	1.50	1.90
225	1.50	1.70	8.74	260	1.10	1.50
250	1.20	1.50	10.66	230	0.80	1.20
275	1.00	1.40	13.01	210	0.60	1.00
300	0.77	1.20	14.18	210	0.50	0.80





ANCHORS AND THEIR INSTALLATION



General Information

Direction of Loading

The direction of the applied load shall be considered to determine the most appropriate anchor.
The tension and shear components shall be lesser than the recommended load/design resistance in the direction concerned.

Tensile Loads

Tensile loads are applied along the axis of fixing (see Fig.1).
Common examples include suspended ceiling applications and the suspension of mechanical services, pipe work, duct work, etc.

Shear Loads

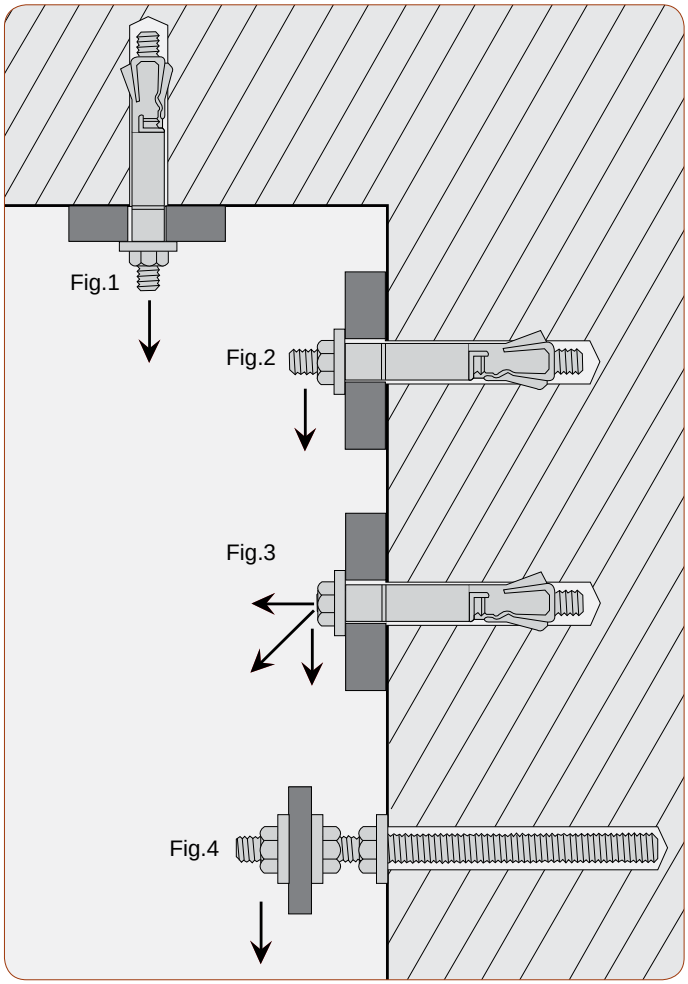
Shear loads act at right angles to the axis of fixing and directly against the face of the structural material (see Fig.2).
Shear performance is governed mainly by the shear strength of the bolt material and by the compressive strength of the supporting substrate.

Oblique / Combined Loads

Oblique loads are a combination of tension and shear components (see Fig.3).
If the angle of the applied oblique load is within 10˚ of pure tension or pure shear, the safe working load for that direction may be assumed. Otherwise, the applied oblique load shall be resolved into its shear and tensile components.

Offset Loads

Offset loads act at right angles to the fixing axis but are offset from the surface (see Fig.4).
In this situation, the deflection of the bolt due to bending needs to be considered as well as the shear capacity of the anchor.



Slotted Holes in Fixture

When fixing anchors through slotted holes; it is important to ensure that there is an adequate surface contact between the washer and the fixture to guarantee a positive clamping force.
If in doubt, a square plate washer with a thickness of 3mm or above would be recommended in place of the standard washer supplied.

Diamond Drilled Holes

When holes are formed in the structure using a diamond drilling system; extra care is required to ensure the holes are thoroughly cleaned by brushing and blowing for at least three times. Also, to make a key for the anchor (particularly if a bonded anchor is installed) the sides of the hole shall be roughened up by inserting a standard masonry bit into the hole attached to a hammer action drilling machine.
A resin with minimal shrinkage shall be selected for diamond drilled holes.

EXPANSION STEEL ANCHOR - STM

Features:
- Suitable for all screws or threaded bolts with metric thread.
- Low energy impact, power-saving assembly.
- Multiple removing and fixing.
- Inside threaded anchor, allows great flexibility.
- Can use variable lengths and art of threaded rods or bolts.
- Small edge distance and small distance between anchors.
- Provide uniform load by tightening the screw or hexagon nut. The cone pulls into the expansion anchor and tightens against the drilled hole.
- Suitable for use in concrete and natural stone.

STM
Expansion Steel Anchor

STM/H

Typical Applications:

Cable trays, cladding fixation, handrails, brackets, staircases, ladders, machines, window panels, base plates, scaffoldings and frameworks .

Technical Data:

Recommended loads (non- cracked concrete C 20/25).

Type (Order No)	Tension Load (kN)	Shear Load (kN)	Bending Moment (Nm)	Screw Grade
M6	2.5	2.3	3.9	8.8
M8	3.3	4.4	17	8.8
M10	4.7	6.5	34	8.8
M12	6.9	8.5	60	8.8

*for cracked concrete we shall use 0.5 x this value (approximately)

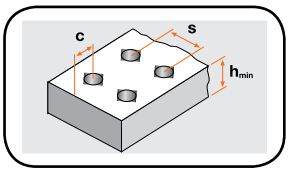
Materials:

- Zinc Plated Steel.
- Stainless Steel [SS 304 (A2) , SS 316 (A4)].

Setting Data:

Edge distance > 1.5 x H *eff.*, distance between anchors > 3 x H *eff.*
Thickness of foundation > 2 x H *eff.*

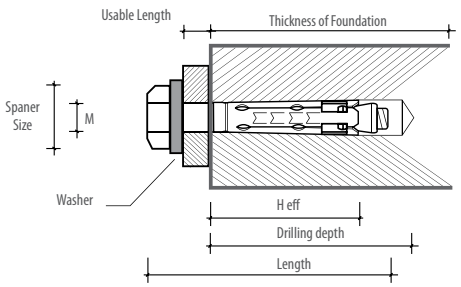
Size	H eff. (mm)	Edge Distance C (mm)	Distance Between Anchors S (mm)	Thickness of Foundation h min (mm)	Washer (Ø)	Tightening Torque (Nm)	Spanner Size (mm)
M6	40	60	120	100	12 x 1.6	10	10
M8	45	68	135	100	16 x 1.6	20	13
M10	55	83	165	110	20 x 2.0	40	17
M12	70	105	210	140	24 x 2.5	75	19



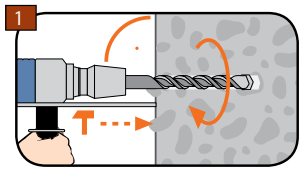
Installation Parameters:

H *eff* = Effective anchorage depth.

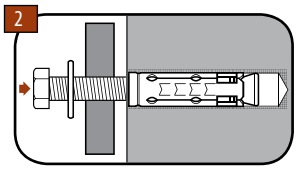
Bolt Size	Length Exp.Unit (mm)	Drill (Ø) (mm)	Drilling Depth (mm)	H eff. (mm)	Usable Length (mm)	Screw Ø x Length (mm)
M6	45	10	55	40	5	M6 x 50
M8	50	12	60	45	10	M8 x 60
M10	60	15	80	55	20	M10 x 80
M12	75	18	90	70	25	M12 x 90



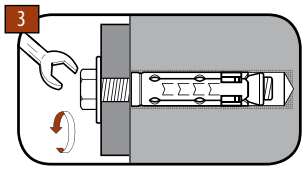
INSTALLATION OF EXPANSION STEEL ANCHOR - STM



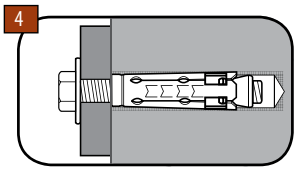
Drill a hole and clean it with a brush, remove dust with a blower.



Place the plug and the object to fix.



Tighten the screw.



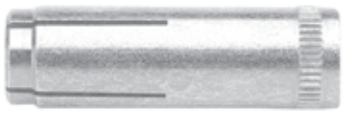
Fixing completed.

DROP-IN ANCHOR - SDA

Features:

- Provides permanently fixed threaded socket in concrete.
- Use in non-cracked concrete or cracked concrete and natural stone.
- The anchor will spread and tighten against the drilled hole after inserting with setting tool.
- Low setting depth, reduced drilling time.
- Enables cost-effective assembly .
- Multiple removing and fixing.

SDA



Typical Applications:

- Pipes, ventilation ducts, suspended ceilings, sprinkler systems, brackets, threaded rods AND cable trays.

Technical Data:

Recommended loads (non- cracked concrete C 20/25).

Thread Size	Tension Load (kN)	Shear Load (kN)	Bending Moment (Nm)
M6	2.4	1.9	3.8
M8	3.2	2.3	9.4
M10	4.9	2.8	16.3
M12	7.3	5.3	32.7
M16	9.8	8.4	75

*for cracked concrete we shall use 0.5 x this value (approximately)

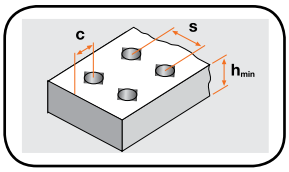
Materials:

- zinc plated steel.
- stainless steel [SS 304 (A2) , SS 316 (A4)].

Setting Data:

Edge distance > 1.5 x effective anchorage depth, distance between anchors > 3.0 x effective anchorage depth, min. thickness of foundation > 2.5 x H *eff*.

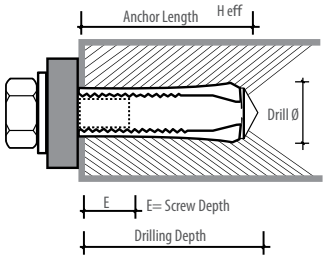
Size	H eff. (mm)	Edge Distance C (mm)	Distance Between Anchors S (mm)	Thickness of Foundation hmin (mm)	Tightening Torque (Nm)	Spanner size
M6	25	37.5	75	100	4	10
M8	30	45	90	100	9	13
M10	40	60	120	130	17	17
M12	50	75	150	140	30	19
M16	65	197.5	195	160	75	24



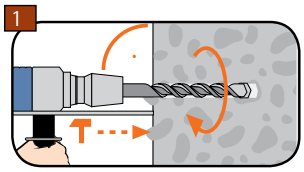
Installation Parameters:

H *eff* = Effective anchorage depth.

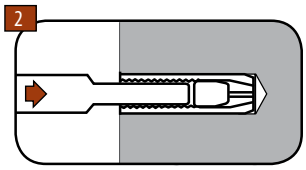
Thread Size	Anchor Length (mm)	Thread Length (mm)	Drill (Ø) (mm)	Drilling Depth (mm)	Effective Anchorage Depth H eff. (mm)	Min. Screw Depth E (mm)	Max. Screw Depth E (mm)
M6	25	11	8	25	25	6	12
M8	30	13	10	30	30	8	13
M10	40	15	12	40	40	10	17
M12	50	20	16	50	50	12	18
M16	65	25	20	65	65	16	23



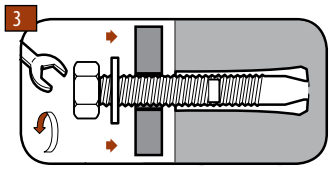
INSTALLATION OF DROP-IN ANCHOR - SDA



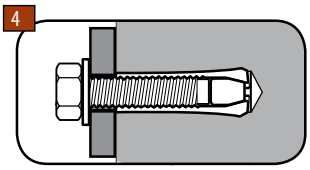
Drill a hole and clean it with a brush, remove dust with a blower.



Insert the anchor sleeve in the hole.



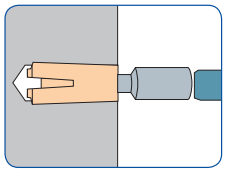
Tighten to the recommended torque.



Fixing completed.

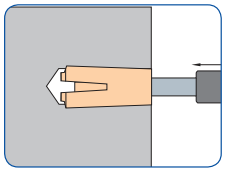
Manual Setting Tool

Use the setting tool to drive the internal wedge into the anchor.



Mechanical Setting Tool

Alternatively use the mechanical setting tool with an appropriate drilling machine.



SLEEVE ANCHOR - SAS

Features:

- Suitable for use in concrete, natural stone, brickwork and blockwork- small distance between anchors.
- Optimum performance in most base material types.
- No protruding threads after installation.
- Small distance between anchors and from edge.
- Controlled expansion.
- Zinc plated > 5µm.
- Effective force distribution in the drilled hole.
- Sleeve anchor with hexagon screw or with threaded bolt.

Typical Applications:

Uni-channel, railings, steel construction machines, high-racks, cable support systems and cladding fixations.

Technical Data:

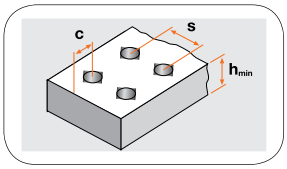
Recommended loads (non- cracked concrete C 20/25).

Bolt Size	Tension Load (kN)	Shear Load (kN)	Bending Moment (Nm)
M6	2.56	2.0	5.0
M8	3.33	3.3	12.5
M10	4.1	5.0	25.5
M12	6.66	7.5	.....

*for cracked Concrete we shall use 0,5 x this value (approximately)

Materials:

- zinc plated steel.
- stainless steel [SS 304 (A2) , SS 316 (A4)].



Setting Data:

Edge distance > 1.5 x effective anchorage depth, distance between anchors > 3.0 x effective anchorage depth, min. thickness of foundation > 2.5 x H *eff.*

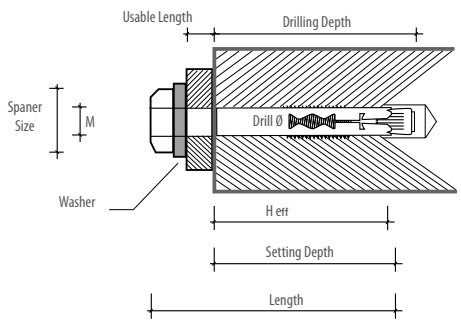
Bolt Size	H eff. (mm)	Edge Distance C (mm)	Distance Between Anchors S (mm)	Thickness of Foundation hmin (mm)	Washer (Ø) (mm)	Tightening Torque (Nm)	Spanner Size
M6	35	52.5	105	70	18 x 1.6	8	10
M8	40	60	120	80	16 x 1.6	25	13
M10	50	75	150	100	20 x 2.0	40	17
M12	75	112.5	225	150	26 x 2.0	50	19

Sleeve Anchor - SAS:

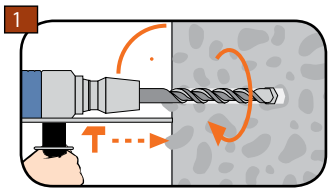
With hexagonal screw (non-cracked concrete C20/25).

Size	Length (mm)	Drill (Ø) (mm)	Hole Ø in Fixture (mm)	Drilling Depth (mm)	Setting Depth (Ø)	H eff. (mm)	Min.Usable Length (mm)
M6	45	8	10	55	35	35	5
M6	60	8	10	55	35	35	15
M8	60	10	12	60	40	40	15
M8	80	10	12	60	40	40	25
M10	70	12	14	70	50	50	15
M10	100	12	14	70	60	50	35

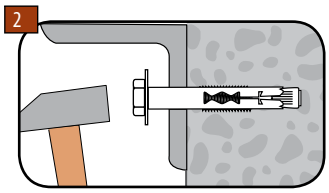
*for cracked concrete we shall use 0.5 x this value (approximately).



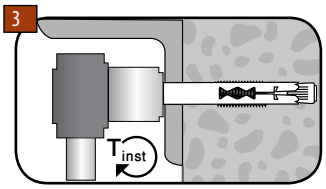
INSTALLATION OF SLEEVE ANCHOR - SAS



Drill a hole and clean it with a brush, remove dust with a blower.



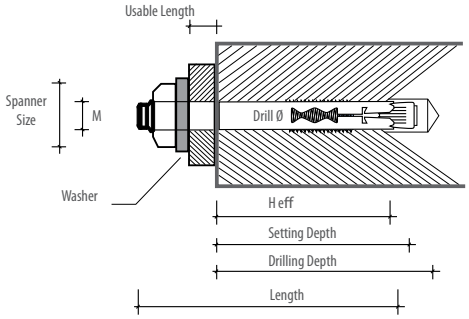
Insert the sleeve anchor through the fixture into the hole.



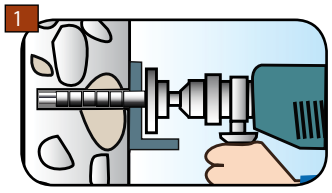
Tighten to the recommended torque.

Sleeve Anchor - SAB:

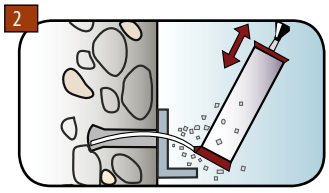
Size	Length (mm)	Drill (Ø) (mm)	Hole Ø in Fixture (mm)	Min.Drilling Depth (mm)	Min. Setting Depth (Ø)	H eff. (mm)	Max. Usable Length (mm)
M6	49	8	10	29	27	25	20
M6	64	8	10	29	27	25	35
M8	60	10	12	34	32	30	25
M8	75	10	12	34	32	30	40
M8	105	10	12	34	32	30	70
M8	85	10	12	34	32	30	50
M10	73	12	14	44	42	40	25
M10	88	12	14	44	42	40	40
M10	108	12	14	44	42	40	60
M10	138	12	14	44	42	40	90
M12	100	16	18	64	62	60	30
M12	120	16	18	64	62	60	50
M16	165	20	22	84	82	80	70



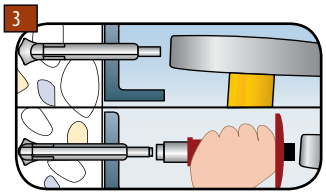
Installation (Push-Phrough Installation)



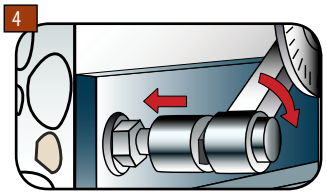
Place the fixture (object) and drill a hole.



Remove dust with a blower and clean the hole with a brush.

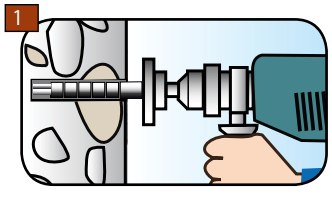


Tap the anchor through fixture with a hammer or a setting tool.

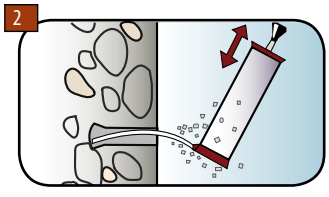


Tighten to the recommended torque.

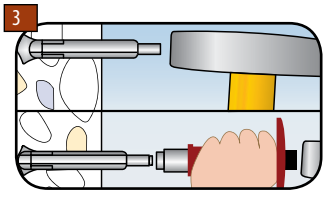
Installation (Pre Positioned Installation)



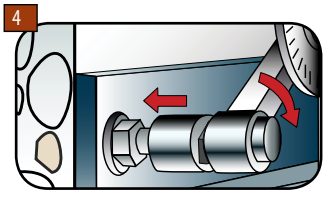
Drill a hole of requested diameter and depth.



Remove dust with a blower and clean the hole with a brush.



Tap with a hammer or a setting tool until fixing depth is reached.



Tighten to the recommended torque.

WEDGE ANCHOR - STB

Through Bolt (Wedge Anchor) - STB

Features:

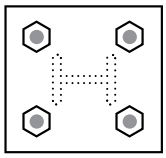
- Suitable for use in cracked concrete or in non-cracked concrete and in natural stone.
- Special design of the clip in stainless steel which ensures a safe hold in the hole.
- Torque controlled expansion.
- Zinc plated > 5µm.
- User friendly, face fixing or through fixing.

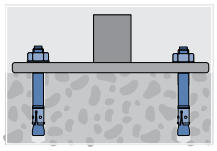
Typical Applications:

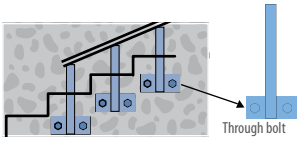
Uni - channel, cladding fixation, hand rails, steel construction, cable trays, supports, brackets, ducts and shelf feet.

Materials:

- Zinc plated steel.
- Stainless steel [SS 304 (A2) , SS 316 (A4)].





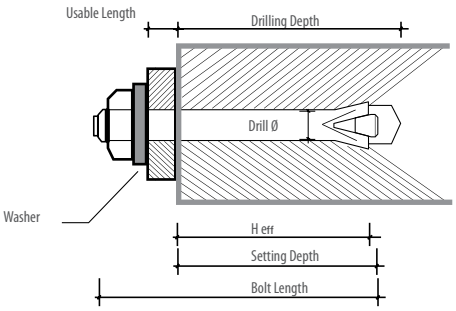


Technical Data:

Through bolt zinc plated (non- cracked concrete C20/25).

Bolt Size	Tension Load (kN)	Shear Load (kN)	Bending Moment (Nm)
M6	2.1	3.0	5.5
M8	4.0	4.8	13.0
M10	5.5	8.5	26.5
M12	7.5	9.5	46.5
M16	13.0	16.0	118.5

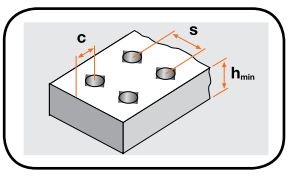
*for cracked concrete we shall use 0,5 x this value (approximately)



Setting Data:

Edge distance > 1.5 H *eff.* , distance between anchors > 3 x H *eff.*
Thickness of foundation > 2 x H *eff.*

Bolt Size	H eff. (mm)	Edge Distance C (mm)	Distance Between Anchors S (mm)	Washer (Ø)	Thickness of Foundation h min (mm)	Tightening Torque (Nm)	Spanner Size
M6	40	60	120	12 x 1.6	100	7	10
M8	50	75	150	16 x 1.6	100	14	13
M10	58	87	174	20 x 2.0	120	30	17
M12	68	102	204	24 x 2.5	140	35	19
M16	80	120	240	30 x 3.0	160	80	24



SFSP

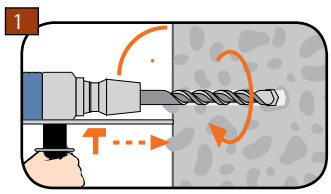
INSTALLATION OF WEDGE ANCHOR - STB

Installation Parameters:
Through bolt zinc plated, stainless steel or hot-dip galvanized.

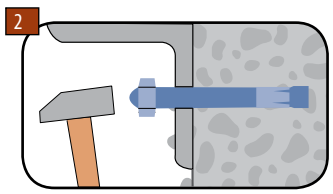
Bolt Size	Bolt Length (mm)	Drill Ø (mm)	Hole Ø in Fixture (mm)	Drilling Depth (mm)	Setting Depth (mm)	H e. (mm)	Usable Length Fix (mm)
M6	40	6	6.5	35	27	.....	3
	55	6	6.5	35	35	35	15
	70	6	6.5	35	35	35	30
	95	6	6.5	35	35	35	55
M8	50	8	9	35	35	.....	10
	65	8	9	40	40	.....	20
	80	8	9	40	40	40	35
	95	8	9	40	40	40	50
	105	8	9	40	40	40	60
M10	65	10	11	40	40	40	15
	80	10	11	50	50	50	20
	95	10	11	50	50	50	35
	115	10	11	50	50	50	55
	120	10	11	50	50	50	60
M12	80	12	13	65	50	50	20
	100	12	13	65	60	60	30
	120	12	13	65	60	60	50
	135	12	13	65	60	60	65
M16	105	16	18	85	70	70	15
	140	16	18	85	80	80	40
	180	16	18	85	80	80	80
	220	16	18	85	80	80	120

H eff.= Effective anchorage depth

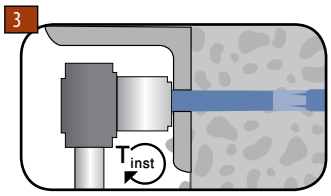
Installation



Drill a hole and clean with a brush, remove dust with a blower.



Place the fixture and insert the through bolt with a hammer.



Tighten to the recommended torque.

V = Very suitable **S** = Somehow suitable **X** = Not suitable

	Concrete	Hollow Concrete Block	Grout Filled Block	Soft Natural Stone	Hard Natural Stone	Immediate Loading
Expansion Steel Anchor	S	S	V	V	S	V
Drop-In Anchor	V	X	S	X	s	V
Sleeve Anchor	V	V	V	S	S	V
Wedge Anchor	V	X	S	X	s	V

FRAMING SYSTEM ACCESSORIES

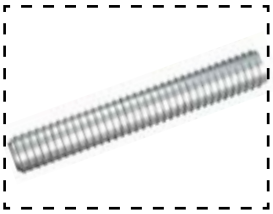
Hexagon Head Bolts

Ordering Codes	Size mm	Qty. per pack
HB0620	M6 x 20	200
HB0650	M6 x 50	200
HB0660	M6 x 60	200
HB0670	M6 x 70	200
HB0850	M8 x 50	200
HB0860	M8 x 60	200
HB0880	M8 x 80	200
HB0830	M8 x 100	200
HB1080	M10 x 80	100
HB10100	M10 x 100	100
HB10120	M10 x 120	100
HB1280	M12 x 80	100
HB12100	M12 x 100	100
HB12120	M12 x 120	100
HB14100	M14 x 100	100
HB14120	M14 x 120	100
HB16100	M16 x 100	100
HB16120	M16 x 120	100

Hexagon Nuts

Ordering Codes	Size mm	Qty. per pack
HN06	M6	500
HN08	M8	500
HN10	M10	200
HN12	M12	200
HN14	M14	200
HN16	M16	200

Threaded Rods



Ordering Codes	Size mm	Qty. per pack
HN06	M6 x 3m	1
TR08	M8 x 3m	1
TR10	M10 x 3m	1
TR12	M12 x 3m	1

Flat Washers

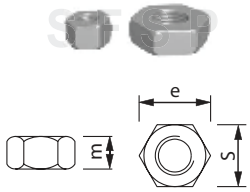
Ordering Codes	Size mm I.D	Qty. per pack
FW06	M6	500
FW08	M8	500
FW10	M10	200
FW12	M12	200
FW14	M14	200
FW16	M16	200

Spring Washers

Ordering Codes	Size mm	Qty. per pack
LW06	M6	500
LW08	M8	500
LW10	M10	200
LW12	M12	200
LW14	M14	200
LW16	M16	200

Hexagon Nuts DIN 934, DIN EN 24032

Hexagon nut (SHN)
DIN 934 or ISO 4032
(= DIN EN 24032)

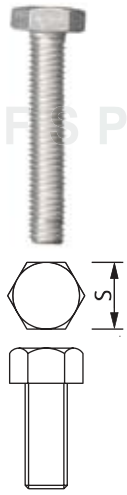


Zinc Plated Thread	Stainless Steel Thread	S/m DIN (mm)	S/m ISO (mm)	e (mm)
M6	M6	10/5	10/6	11.5
M8	M8	13/6.5	13/7.5	15.0
M10	M10	17/8	16/9.5	19.6
M12	M12	19/10	18/12	21.9
M16	M16	24/13	24/15.5	27.7

Order Example : SHN - M 12

Machine HexHead Bolts DIN 933, DIN 24017

Hex Head Bolt (SHB)
DIN 933 or
EN 24017
(without nut)

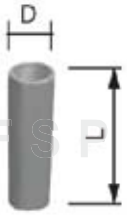


Zinc Plated Dimension	Stainless Steel Dimension	S DIN (mm)	S EN (mm)
M 6 x 12	-	10	10
M 6 x 25	-		
M 8 x 25	M 8 x 25	13	13
M 8 x 40	-		
M 10 x 20	-	17	16
M 10 x 30	M 10 x 30		
M 10 x 45	M 10 x 45		
M 10 x 60	-		
M 10 x 70	-		
M 12 x 22	-	19	18
M 12 x 25	M 12 x 25		
M 12 x 30	M 12 x 30		
M 12 x 40	M 12 x 40		
M 12 x 50	-		
M 12 x 60	M 12 x 60		
M 12 x 80	M 12 x 80		
M 12 x 90	-		
M 16 x 40	M 16 x 40	24	24
M 16 x 60	M 16 x 60		
M 16 x 90	M 16 x 90		

Order Example : SHB - M 12

Coupler Sleeves Rounded

Coupler Sleeves (SCS)



Electroplated Thread	Stainless Steel Thread	D (mm)	L (mm)	Load cap. (KN)
M6	M6	10/10	15	2.2
M8	M8	12/14	20	4.0
M10	M10	13/16	25	6.4
M12	M12	16/20	30	9.3
M16	M16	21/25	40	17.3
M20	M20	26/32	50	27.0

Order Example: SCS - M 16

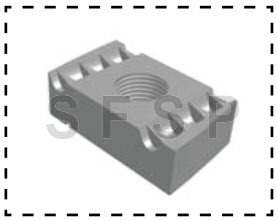
Hexagonal Rod Coupler

Hexagonal
Rod Coupler
with view
hole (SHR)

Electroplated Thread	Stainless Steel Thread	S (mm)	L (mm)	Load cap. (KN)
M10	M10	13	40	6.4
M12	M12	17	40	9.3
M16	M16	22	50	17.3

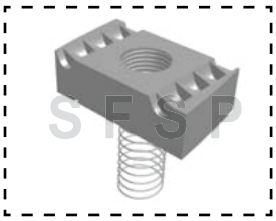
Order Example: SHR - ZP - M 12

Channel Nuts



Nut without Spring

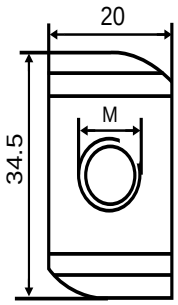
Nut with Short Spring

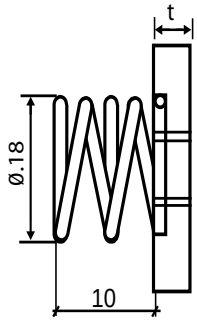


Nut with Long Spring

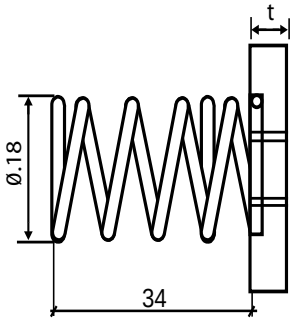
Hammer Head Bolt

Material: Zinc plated steel and stainless steel 304 (A2),316 (A4).
Tolerance: Metric thread 6 H acc. DIN 13-20.

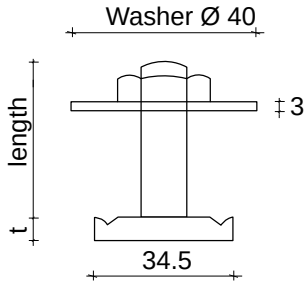




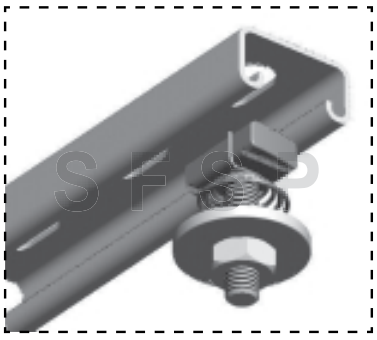
Short Spring



Long Spring

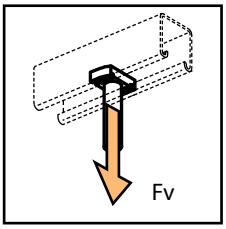


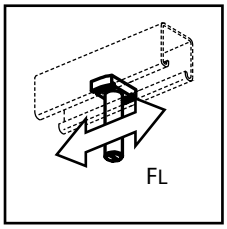
Available length: L 30mm, 40mm, 50mm, 60mm.
Material: Zinc plated.



Thread Size	Thickness t (mm)	Longitudinal Force FL (kN)	Pull out Force Fv (kN)	Tightening Torque (Nm)
M6	5.0	1.0	5.0	12.0
M8	6.0	2.4	6.0	28.0
M10	8.0	3.5	7.0	55.0
M12	10.0	5.0	9.0	75.0

Threaded Size	Pull out Force Fv (kN)	Longitudinal Force FL (kN)	Tightening Torque (Nm)
M6	5.0	0.3	6.5
M8	6.0	0.6	16.0
M10	7.0	1.2	31.5
M12	7.0	1.7	50.0



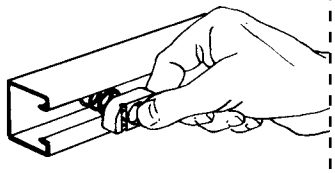


Note: Do not exceed channel capacity

Installation & Features

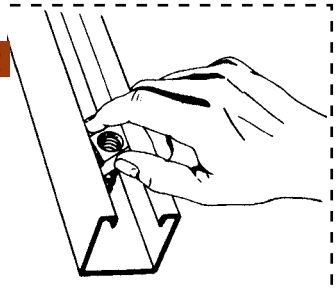
No Welding , No Drilling , No Special Tools, Strong, Fast, Economical and Adjustable.

1



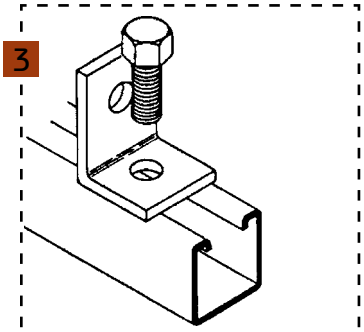
Insert the spring nut anywhere along the continuous slotted channel. The rounded nut ends permit easy insertion.

2

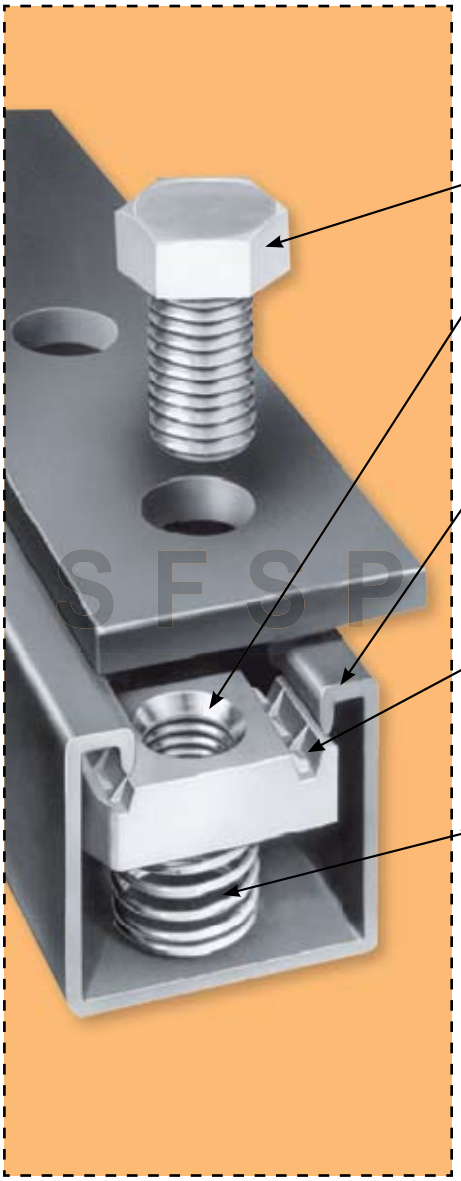


A 90° clockwise turn aligns the grooves in the nut with the inturned edges of the channel. The need for drilling holes is eliminated.

3



Insert the bolt through the fitting and into the springnut. (See illustration 5 for end view showing the nut in place)



Hex-head bolt connects fitting to channel as it is threaded into spring nut.

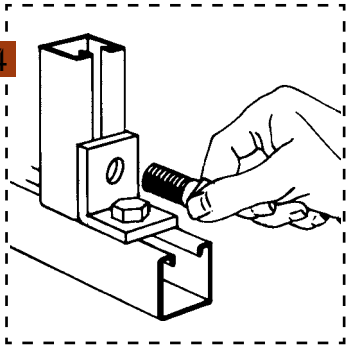
Chamfer in the nut eases starting of the bolt. Nut teeth make a strong, vise-like grip when tightened against the inturned channel edges.

Channel edges and the nut's tapered grooves act as guides to provide fool-proof alignment of connection.

Nut teeth grip the channel's inturned edges, tying the channel sides together in a "box" configuration for added strength.

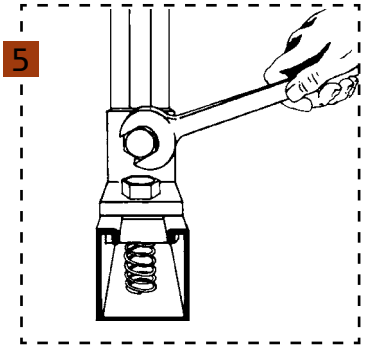
Spring allows precision placement anywhere along channel length, then holds the nut in position while the connection is completed.

4



Additional channel sections can now be bolted to the fitting already in place by following procedure described in steps 1–3.

5



Tightening with a wrench locks the serrated teeth of the nut into the inturned edges of the channel, to complete a strong, vise-like connection.

1. Introduction

Stainless steel components are widely used for the support and fixing of cladding panels to buildings.
The long term durability and corrosion resistance of stainless steel makes it ideally suited to this application where there is a likelihood of a corrosive working environment for the cavity fixings.

BS 449, the structural use of steel in buildings, contains rules for the application of stainless steel bolts and the calculation of their maximum working stresses.
It may be noted that where as BS 449 is based on a permissible stress approach, revised or new codes, such as BS 5950 which is to eventually replace BS 449, are written in terms of limit states. Thus, the design of stainless steel components will also be to limit state principles.

2. Materials Grades and Properties at 20°C

The following grades of stainless steel are recommended for fixing applications.
2.1 Plate, sheet & strip.
The relevant British Standards for the materials are:
BS 1449 : Part 2: 1983 and BS 1501: Part 3: 1973

Table 1

Plate, Sheet & Strip- Material to BS 1449: part2:1983				
Grade	**Supply Condition**	**UTS N/mm² (Min)**	**0.2%Proof Stress N/mm² (Min) 20°c**	**Elongation (Min)**
304S11	Softened	480	180	40%
304S15	Softened	500	195	40%
316S11	Softened	490	190	40%
316S31	Softened	510	205	40%
321S31	Softened	500	200	50%

The hi-proof stainless steels produced to BS 1501: Part 3: 1973 have increased strengths due to the inclusion of nitrogen.
Values for hi-proof steels are shown in the standard in terms of UTS and 1% proof stress. Corresponding values for 0.2% proof stress are approximately 30% higher than material to BS 1449.

Table 2

Plate - Hi-Proof Material to BS 1501: part 3				
Grade	**UTS N/mm² (Min)**	**1%Proof Stress N/mm² (Min)**	**0.2%Proof Stress N/mm² (Min) 20°c**	**Elongation (Min)**
304S62	590	315	(250)	35%
304S65	590	315	(250)	35%
316S62	620	340	(270)	35%
316S66	620	340	(270)	35%

MATERIALS

MATERIALS

Mild Steel - Plain

A. Hot Rolled Steel Plates, Sheets and Coils S235 JR, S355 JR,
As per:
EN 10025 -2 / DIN 17100 / BS 4360 / ASTM A 653M / ASTM A 1011/ ASTM A 1011-01a
JIS 3101 / JIS 3106 / GB 700 / GB / T1591.
ASTM A 907 / ASTM A 1018M.
ASTM A 570M / ASTM A 572M.

B. Cold Rolled Steel DC 01,
As per:
EN 10130 / DIN 1623, Part 2 / BS 1449:1 / ASTM A366 / ASTM A 1008 / JIS G 3141 / GB 699.
EN 10131 / ASTM A 568M

Mild Steel - Galvanized

C. Continuously Pre- Galvanized Hot–Dip Zinc Coated Steel DX 51D + Z,
As per:
EN 10327 / DIN 17162 / BS 2989/ ASTM A 527M / ASTM A 653M / JIS G 3302.
EN 10326/ EN 10142 / ASTM A 526, 527, 528/ ASTM A 146

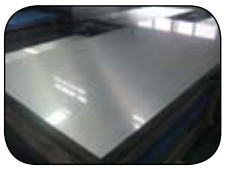
D. Electro Galvanized Steel (Electrolytic Coating) DC01 + ZE,
As per:
EN 10152 / DIN 17163 / ASTM A591 / JIS G 3313 / JIS G 3141/BS 1449:1
EN 10131

AluZink Steel

E.AluZink Steel DX 51D + AZ,
As per:
EN 10215 / EN 10143/ DIN 55928 / ASTM A 792

Stainless Steel

F.Austenitic Stainless Steels AISI 304 & 316,
As per:
ASTM A 240 /EN 10088-2/ DIN 17400 / BS 1449:2 /
ASTM A480 / ASTM A666 / ISO 3506 / EN 10028-7 /JIS G 4304
F.1 Stainless Steel Fasteners EN 3506
F.2 Stainless Steel Wire BS 1554 ,ASTM A276



Aluminium

G.Aluminium 5052 & 6063

FINISHES

1- Hot–DIP Galvanization after Fabrication,
As per:
ASTM A 123 / ASTM A 153 / ISO 1461.
BS 729 / DIN 50976

2- Zinc Electroplating after Fabrication,
As per:
ASTM B633 / EN 12329 / ISO 4042/ BS 1706 / BS 3382 / DIN 50961

3- Powder Coating
Epoxy / Polyester / Epoxy & Polyester
BS 3900 / ISO 2409 / ISO 1519 / ISO 1520

For more details see pages at the end of the catalogue

Mild Steel

A. Hot-Rolled Steel Coils and Plates / S235 JR, S355 JR

- Sheets and coils (flat products of ordinary quality).
- Non-alloy steels EN 10025-2: 2004 / S235 JR, S355 JR.

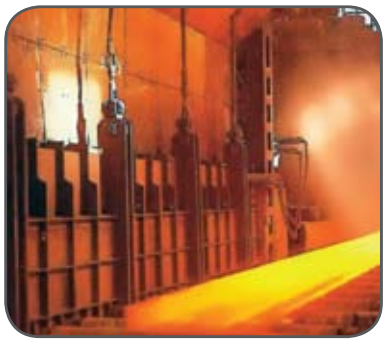
Designations and Comparisons Between Designations:

Euro Norm	Euro Norm	Euro Norm	Germany	U.K.	France	USA	USA
EN 10025-2	EN 10025:1990 + A1 : 1993	EN 10025: 1990	DIN 17100 : 1983	BS 4360: 1996	NF A 35-501	ASTM A283M (A633M)	ASTM A 1011 – 01a CS
S 235 JR	S 235 JR G2	Fe 360 B	RST 37 - 2	40 (A) B	E24 -2	Grade C & D	SS Grade 33
S 355 JR	S 355 JR	Fe 510 B	St 52 -3	50 B	E36 - 2	Gr. C & D	SS Grade 50

Japan		China	India	International
JIS 3101	JIS 3106	GB 700 (GB / T 1591)	IS	ISO
SS 400	SM 400 A	Q 235 B	IS 226	E 235 B
SS 490	SM 490 A	(Q 345 B)	IS 961	(E355C)

Mechanical properties:

Name	Grade Number	Yield Stress Re N/mm²	Tensile Strength Rm N/mm²	Impact Strength KV J	t °c
S 235 JR	1.0037	≥ 235	360 - 510	27	20
S 355 JR	1.0045	≥ 355	510 - 680	27	20



Notes:

- S235 JR : S = Structural steel ; 235 = Minimum yield strength in N/ mm² or MPa.
JR = Flat products; longitudinal charpy v-notch impact strength class 27 J @ 20 °C.

- BS 4360, is gradually being replaced by EN 10025 BS 1449 steel plates, sheets and strips.

- Fittings are manufactured from steel meeting the minimum requirements of ASTM A907 SS, Grade 33.

- ASTM A907 / A907M-96 withdrawn in 2001 and replaced by A 1018 / A1018M. Covers hot rolled heavy –thickness carbon – steel sheet and strip of structural quality in coils beyond the size limits of specification A570 / A570M.
CS = Commercial Steel , SS = Structural Steel.
DS = Drawing Steel, SQ = Structural Quality.

- ASTM A 1011 (formerly ASTM A570 and ASTM A572); SS Grade 33 : SS = Structural Steel, 33 = Minimum yield stress R_p 0.2 = 33 ksi = 230 MPa = 230 N/ mm².
(To convert from ksi (kilo square inch) to MPa (Mega Pascal) or N/ mm² multiply by 6.97).

- Temporary anti-corrosion protection. (made by oiling)
Slight oiling : 0.4 – 0.7 g/m² on each side.
Medium oiling : 0.8 – 1.2 g/m² on each side.
Heavy oiling : 1.3 – 2.0 g/m² on each side.
(Oiling is done by: mineral oil, esters and additives)

- Tolerances are set down in EN 10151:1992.

- Standard for dimensions : EN 10162.

B. Cold Rolled Steel / DC01

- Mild unalloyed steel grades for cold forming

Designations and Comparisons Between Designations:

Euro Norm	Germany	U.K.	France	Italy	USA	Japan	India	China
EN 10130	DIN 1623, Part 2	BS 1449: Part 1	N FA 36-401	UNI 5866	ASTM A366	JIS G 3141	513/94	GB699 - 88
DC01	St12 (Fe P01)	CR4	F12	Fe P01	(SAE 1010)	SPCC	O	Gr. 08/08F

DIN, BS, NFA & UNI are replaced by Euro Norm.

Mechanical Properties:

Name	Grade Number	Yield Stress Re N/mm²	Tensile Strength Rm N/mm²	Fracture Elongation A 80 %
DC 01	1.0330	140 - 280	270 - 410	≥ 28

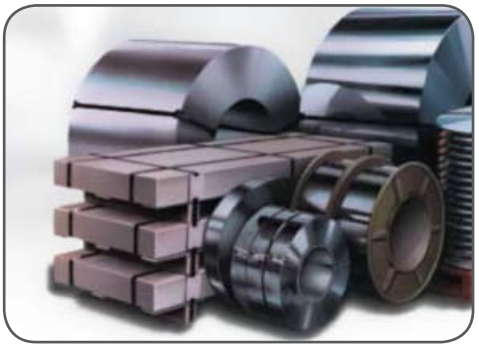
Surface Quality:

Euro Norm	Germany	U.K.	France	Italy	USA
EN 10130	DIN 1623, Part 2	BS 1449: Part 1	N FA 36-401	UNI 5866	ASTM A366
A	3	GR (General Purpose)	X	MA	CLASS 2
B	5	FF (Full Finish)	Z	MB	CLASS 1

A = normal surface quality.
B = best surface quality.

Surface Finish:

- Dull finish or matte.
- Bright finish.



Surface Treatment:

P	Phosphated
PC	Phosphated & Chemically Passivated
PO	Phosphated & Oiled
C	Chemically Passivated
CO	Chemically Passivated & Oiled
O	Oiled
U	Untreated

Notes :

- *Tolerances to DIN EN 10131, ASTM A568.*
- *Commercial quality by steel (CS), ASTM A366 and ASTM A1008 CS type B.*

C. Continuously Pre-Galvanized Hot–Dip Zinc Coated / DX51D + Z

- Steel sheets, strips and coils for cold forming(forming & drawing quality) (Lock Forming Quality LFQ).

Designations and Comparisons Between Designations:

Euro Norm	Germany	U.K.	France	Italy	USA	USA	Japan	India
EN 10327 (EN DIN / EN BS)	DIN 17162 /1	BS 2989	NFA 36- 421	UNI 5753	ASTM (old)	ASTM (amendment)	JIS G 3302	IS
DX 51 D + Z	St 02 Z (Fe P02 G) Z	Z 2	GC	Fe P02 G	A 527 M	A 653 - LFQ	SG CD1	D

Mechanical Properties:

Steel Grade	Grade Number	0.2 % - Proof Stress R_p 0.2 N/mm²	Tensile Strength Rm N/mm²	Fracture Elongation A 80 %
DX51 D + Z	1.0226	140	270 - 500	≥ 22

Surface Finish:

Euro Norm	Germany	U.K.	France	Italy	USA	Japan
EN 10142 /147	DIN 17162/1	BS 2989	NFA 36-421	UNI 5753	ASTM A146	JIS G 3302
NA	NA	Spangle N	NA	Regular Spangle	Regular Spangle	Regular Spangle
MA	MA	Minimum Spangle M	MA	Minimized Spangle	Minimized Spangle	Minimized Spangle
MB	B	Smooth	B	Skin passed	-	Skin passed
MC	C	Extra Smooth XS	C	-	-	-

Appearance:

N = Normal rose pattern.
M = Reduced (minimized) rose pattern.

Zinc Coating Surface Finish:

- Normal or regular spangle

This finish is obtained during normal solidification of a hot-dip zinc coating on steel, and results in the formation of a coating which exhibits either no spangle or zinc crystals of different sizes and brightness. However, the zinc appearance has no effect on either the quality or corrosion resistance of the coating.

- Flattened minimized spangle

This zinc coating finish is obtained by restricting the normal zinc crystal growth followed by the application of a skin pass process.
It is recommended for applications where a high gloss paint finish is required.
Where it can mass up to Z275, and a maximum material thickness of 1.20 mm if passivation is required, or a maximum thickness of 1.60 mm if passivation is not required.

Quality:

- Normal surface: errors on surface can occur.
- Improved surface: Small errors are allowed (skin passing).
- Best surface: one error free side (skin passing).

MATERIALS

Coating Thickness:

Euro Norm	Germany	U.K.	France	Italy	USA	Japan
Z100	100	G100 (100 g/sqm)	Z100	Z100	G40	Z 12 (120 g/sqm)
Z120	-	-	-	-	-	
Z140	-	-	-	-	-	
Z200	200	G200 (200 g/sqm)	Z200	Z200	G60	Z 18 (180 g/sqm)
Z225	-	-	-	-	-	
Z275	275	G275 (275 g/sqm)	Z275	Z275	G90	Z 27 (270 g/sqm)
Z350	350	G350 (350 g/sqm)	Z350	Z350	-	Z 35 (350 g/sqm)

(G60 means 0.6 oz/ft2 coating thickness) (to convert from oz/ft2 to g/m2 multiply by 306)

Zink Layer:

Coating Designation	Minimum Coating Mass g/m²		Coating Thickness µm
	Triple Spot Test	Single Spot Test	
Z100	100	85	7
Z120	120	90	8
Z140	140	120	10
Z200	200	170	14
Z225	225	195	16
Z275	275	235	20
Z350	350	300	25

- The coating weight of an area of 1 m² including both surfaces.
- Coating thickness (µm) is calculated from triple spot test values, and is for one side only.

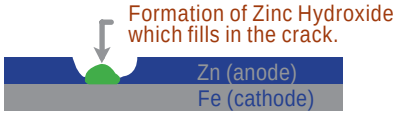
Surface Treatment:

C	Chemical Passivation
O	Oil
CO	Chemical Passivation and Oil
U	Unoiled and Unpassivated

Notes:

- *DX 51D Bending and profiling quality in ASTM is CS Type B (Commercial Steel Type B).*
- *Hot – dip galvanized steel is produced on continuous zinc coating lines from either cold rolled (thickness range 0.27 to 2.0 mm) or hot rolled (thickness range 2.01 to 3.0 mm) steel substrate; it is produced to the requirements of EN 10327, EN 10326, EN 10142, EN 10143, ASTM A 653M (Grade 33).*
- *EN 10327 supersedes EN 10142.*
- *Hot rolled substrate.*
  Due to the nature of the hot rolling process, surface blemishes such as surface scratches and coil breaks which may be high lighted by the zinc coating, can occur on materials with a thickness of greater than 2.01 mm. Neither of these defects will affect the functionality of the materials.
- *Wet storage corrosion "white rust".*
  Normally light white staining on galvanized steel is not a reason for concern.
  Either under a heterogeneous film of water, or under permanent condensation, white rust appears on the surface of the steel sheets.
  It is a precipitation of basic salts of zinc Zn (OH)2 that combines with CO_2 to form a protective layer called Zinc Hydroxycarbonate.
- *In case of ASTM specification, the specification of hot-dip galvanized steel sheet IS unified as ASTM A653. - However the former specifications likely to ASTM A526, A527, A528 are also used.*
- *Bending Quality of EN specification is called Lock Forming Quality (LFQ) in JIS or ASTM.*

Performance in Dry Atmosphere:



Parts can be used in dry atmosphere without influence of aggressive particles. The cut edge of these sheets with a thickness of up to 1.5 mm are by experience sufficiently protected by the cathode protection against corrosion in an almost dry atmosphere.

Period for First Maintenance:

Pre-galvanized, hot-dip zinc coated steel - typical period (years) for first maintenance			
Mass g/m² including both surfaces	Coastal	Industrial and Urban	Suburban and Rural
275	2-5	2-5	5-10
350	2-5	2-5	5-10

D. Electro-Galvanized Steel (Electrolytic Coating) / DC01 + ZE

- The base material for electrolytically coated steel is cold-rolled, annealed, lightly temper – rolled strip.

Designations and Comparisons Between Designations:

Euro Norm	Euro Norm	Germany	U.K.	France	Italy	USA	Japan	Japan
EN 10152	EN 10152 - 92	DIN 17163-88	BS 1449 /1	NF 36-401	UNI 5866	ASTM A146	JIS G 3313	JIS G 3141
DC 01 + ZE	Fe P01 ZE	St 12 ZE	CR 4	C	Fe P01	A591 - CQ	SECC	SPCC

Mechanical Properties:

Name	Grade Number	Yield Stress	Tensile Strength	Elongation
		Re N/mm²	Rm N/mm²	A80 %
DC 01 + ZE	1.0330	140 - 280	270 - 410	≥ 28

Coating Thickness (EG):

Coating Designation*	Nominal Zinc Coating Values for each surface		Minimum Zinc Coating Values for each Surface		Marking
	Thickness Mass		Thickness Mass		
	µm	g / m²	µm	g / m²	
ZE 25 / 25	2.5	18	1.7	12	E16 ZE 25/25
ZE 30 / 30	5.0	36	4.1	29	E24 ZE 50/50
ZE 50 / 50	7.5	54	6.6	47	E40 ZE 75/75
ZE 100 / 100	10.0	72	9.1	65	ZE 100/100

(to convert from g /m² to oz / ft² , multiply by 0.00327)

*After BSEN 10152:1994

Surface Treatment:

P	Phosphated
PC	Phosphated & Chemically Passivated
PO	Phosphated & Oiled
C	Chemically Passivated
CO	Chemically Passivated & Oiled
O	Oiled
U	Untreated

Surface Finish :

- m = normal.
- r = rough.

Surface Quality:

A = normal quality / standard.
B = best quality / full finish.

Notes :

- *Tolerances : on dimensions and shape to DIN EN 10131.*
- *ZE = Pure Zinc electrolytic coating.*

ALUZINK STEEL

E. Aluzink Steel / DX51D + AZ

Steel for Forming:

Euro Norm	Germany	USA
EN 10215 / 10143	DIN 55928/8	ASTM A792
DX 51D + AZ		

Aluzink Layer:

Weight class	Aluzink weight g / m² , sum of both sides	
	Triple spot test	Single spot test
AZ 100	100	85
AZ 150	150	130
AZ 165	165	150
AZ 185	185	160
AZ 200	200	170

Surface Treatment:

C	Chemical passivation
O	Oil
S	Anti finger print (ALC – Surface)
CO	Chemical passivation and Oil

Appearance:

M = Normal rose pattern.

Quality:

A - Normal surface: errors on surface can occur.
z z - Improved surface: small errors are allowed.

Stainless Steel

WHAT IS STAINLESS STEEL?

Stainless steel is not a single specific material:
It is the name given to a group of corrosion resistant steel alloys which contain a minimum of 12% chromium.
The chromium in stainless steel reacts with oxygen in the air to produce a very thin, inert, chromium rich oxide film on the surface of the steel. It is the presence of this film which provides the corrosion resistance of stainless steel.
This passive film is unlike coatings such as paint or galvanizing in one very important way. If it is damaged by abrasion or mechanical means such as cutting, it re-forms and continues to protect the steel.

WHY USE STAINLESS STEEL?

Stainless steel has been used with success by the construction industry throughout the UK and Europe for over fifty years. Its use has increased rapidly in recent times as the benefits of stainless steel over traditional materials have become more widely recognized.
Stainless steel offers many advantages to the specifier:

- Excellent corrosion resistance
- High ductility and strength
- Non-magnetic
- Excellent high and low temperature properties
- Resistance to unsightly staining
- Life-cycle costing benefits
- Aesthetic surface finish

Life-cycle costing is increasingly recognized as the true way to establish the cost of building components.
The maintenance-free life and confirmed integrity of stainless steel mean that no costly remedial or refurbishment measures are required during the life of the structure.
As the trend to higher specification and longer life continues, stainless steel will provide cost effective long term solutions to specifiers' problems.

TYPES OF STAINLESS STEEL

Austenitic Stainless Steels

Austenitic stainless steels offer excellent resistance to corrosion. These high chromium steels are ductile and strong. They are non-magnetic and can be readily formed and welded. Higher strengths can be obtained by cold working, although this makes the metal slightly magnetic and may reduce its corrosion resistance. Austenitic stainless steels are widely used in the construction, pharmaceutical and chemical industries.

Martensitic Stainless Steels

The high carbon content of martensitic steels means they can be hardened by heat treatment; ultimate tensile strengths in excess of 1300 N/mm^2 can be obtained. They are magnetic and cannot usually be welded. Although they are cheaper than austenitic steels, their low corrosion resistance limits the range of suitable applications to components such as valves, dies and knife blades.

MATERIAL SPECIFICATION

There are many grades of stainless steel resulting in a proliferation of national and international specifications. The two main grades of austenitic stainless steel used in the manufacture of SFSP products are 1.4301 (304) and 1.4401 (316). Some products may be available in 1.4003 ferritic stainless steel as an alternative to coated carbon steels.
These grades of stainless steel are adequate for almost all construction applications, however grades which have even greater pitting or corrosion resistance can also be supplied. Please contact the SFSP Specification Services Team for further advice.
All plate material meets the chemical composition and mechanical property requirements of the new European material standard for stainless steel, BS EN 10088.

Grade 1.4301 (304)

This austenitic grade is the most commonly used and is suitable for a broad range of construction applications. It typically contains alloying elements of at least 18% chromium and 8-10% nickel. Marginal differences in composition have no significant effect on the material's excellent all-round corrosion resistance.

Grade 1.4401 (316)

This austenitic grade is recommended for highly corrosive areas such as marine locations or heavily polluted industrial environments. The addition of a small proportion of molybdenum (around 2%) and an increase in the nickel content to 10-13% provide a more robust passive film and hence higher resistance to corrosion.

Grade 1.4003

This is an economy grade ferritic stainless steel with a 12% chromium content. It was developed as a superior alternative to coated carbon steels and other materials with poor corrosive and abrasive resistance. Grade 1.4003 is suitable as a cost-effective, and more durable alternative to galvanized steel for wind posts and miscellaneous brackets.
This grade should not be used where an aesthetic surface finish is required. It may form a light surface rust colored patina. This discolouration is superficial and does not affect the mechanical properties of the steel.

F. Austenitic Stainless Steels /AISI 304 & 316

- EN 10088-2/ ASTM A240/ ASTM A480 / ASTM A666

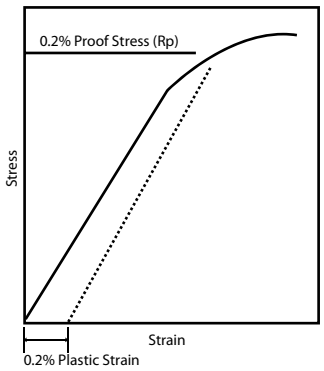
Designations and Comparisons Between Designations :

USA	Euro Norm	Germany	UK	France	Japan
ASTM A240 AISI	Steel name EN 10088-2	DIN Steel number 17440	BS 1449: Part 2	AFNOR	JIS G 4304
304 *	X5 CrNi 18 - 10	1.4301	304S31	Z7CN 18.09	SUS304
304 L	X2 CrNi 18 – 11	1.4306	304S11	Z3CN 18.10	SUS304L
316 *	X5 CrNi MO 17 – 12 – 2	1.4401	316S31	Z7CND 17.11.02	(SUS316)
316 L	X2 CrNi MO 17 – 13 - 2	1.4404	316S11	Z3CND 17.12.02	SUS316L

Mechanical Properties: 90°c - 50°c

			Work Stress	
AISI	Minimum 0.2 % Proof Stress Rp (N/mm²)	Ultimate Tensile Strength Rm (N/mm²)	Tension / Compression (N/mm²)	Shear (N/mm²)
304	177	520 – 720	160	93
304 L	154	485 – 650	140	81
316	190	520 – 670	172	99
316 L	177	500 - 670	160	93

Typical Stress/Strain Curve for Stainless Steel



Stress-Strain Curve:

Stainless steels differ from mild steels in the sense that stainless steels do not exhibit a well defined yield point when exposed to tensile load.

Some Stainless Steel Finishes:

ASTM	EN 10088 – 2	Thickness (mm)	Description
No. 1	1 D	3.0-5.0	Hot rolled, annealed and pickled
2 B	2 B	0.3-6.0	Heat treated, annealed and pickled after cold rolling skin - passed
No. 4	2 J	0.4-3.0	Polished with abrasive mesh of 150 - 180 grain

Notes :

-Type 304 – the most common grade; the classic 18/8 stainless steel. Also referred to as "A2" in accordance with ISO 3506.

-Type 304 L – the 304 grade but specially modified for welding.

-Type 316 – the second most common grade (after 304), alloy addition of molybdenum prevents specific forms of corrosion, also referred to as "A4" in accordance with ISO 3506.

-Type 316L – the 316 grade but specially modified for welding.

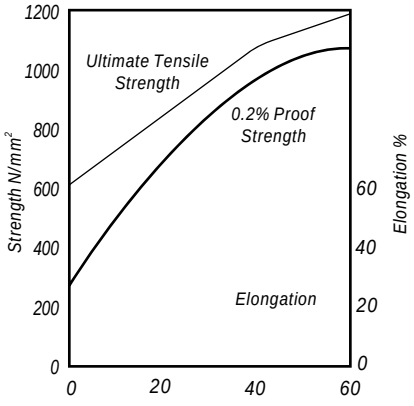
-Modulus of Elasticity 193,000 (N/mm²).

-Density 7.92 to 7.94 g/cm³.

-EN 10088-2 replaces BS 1449- part2.

-EN 10028-7 replaces BS 1501- part3.

Effect of cold working in grade 304 Stainless Steel



Effect of Cold Work:

- The working of austenitic stainless steel significantly increases the proof strength.
- Localized cold working arises during the forming of angle and channel sections.
- The benefits of this cold working are not taken into account in SFSP's designs, but it provides additional reserves of strength.

National and European Specifications for Equivalent Grades of Stainless Steel

EN 10088 Number	EN 10088 Name	BS 1449
1.4301	X5CrNi 1810	304S31
1.4306	X2CrNi s189	304S11
1.4401	X5CrNiMo 17122	316S31
1.4404	X2CrNiMo 17132	316S11

Commonly used Grades for Flat Products and their Applications, Properties and Design Stresses at 20°c

Grade	Alloying Elements	Applications	Minimum 0.2% Proof Stress Rp (N/mm^2)	Ultimate Tensile Strength Rm (N/mm^2)	Elongation After Fracture (%)	Working Stresses	
						Tension Compression (N/mm^2)	Shear (N/mm^2)
1.4301 (304)	Chromium- nickel steel (Basic stainless steel)	Suitable for rural, urban and light industrial sites. Regular washing down is recommended for exposed architectural features to maintain a good appearance.	210	520 - 720	45	140	93
1.4306 (304L)	Low carbon chromium- nickel steel (lower carbon content improves resistance to intergranular corrosion of thick sections following welding)	Not suitable for exposure in heavily polluted industrial or coastal sites. Low carbon grades need only be considered for welded fabrications involving plates thicker than 16-20mm depending on the welding procedure.	200	500 - 650	45	133	89
1.4401 (316)	Chromium-nickel-molybdenum steel (molybdenum greatly improves overall corrosion resistance and especially pitting resistance)	Suitable for industrial and coastal sites. Tarnishing or staining may occur; regular washing down is recommended for exposed architectural features to maintain a good appearance.	220	520 - 670	45	146	97
1.4404 (316L)	Low carbon chromium-nickel-molybdenum steel (lower carbon content improves resistance to intergranular corrosion of thick sections following welding)	Low carbon grades need only be considered for welded fabrications involving plates thicker than 16-20mm depending on the welding procedures.	220	520 - 670	45	146	97

Notes: the properties and design stresses are for hot rolled plates to EN 10088. SFSP is able to use higher stresses in accordance with S.C.I. recommendations in the "Concise Guide to the Structural Design of Stainless Steel", available from the Steel Construction Institute, Silwood Park, Ascot, Berkshire SL5 7QN.

Bi-Metallic Contact

When two dissimilar metals are in contact in the presence of an electrolyte, bi-metallic corrosion may occur. This may result in the corrosion of the base metal while the noble metal is protected. Where contact is unavoidable and moisture is likely to be present, the two metals should be separated.
The table of recommendations indicates which metals may, in certain circumstances, be used together.
The degree of corrosion resulting from bi-metallic contact depends collectively upon:
- The metals in contact
- The environmental conditions
- The time that the contact remains wet or moist
- The relative surface areas of the anodic (carbon steel) and cathodic (stainless steel) metals

Prevention is possible by excluding water from the detail (painting or taping over the assembled joint) or by isolating the metals from each other (painting the contact surfaces of the dissimilar metals or using isolation patches).
Isolation around bolted connections can be achieved by non-conductive waterproof gaskets and nylon or Teflon washers and bushes.

The general behavior of metals in bi-metallic contact in rural, urban, industrial and coastal environments is fully documented in PD 6484 :
Commentary on corrosion at bi-metallic contacts and its alleviation.

Measures to Prevent Corrosion

There are four types of corrosion prevention measures, which can be differentiated in descending order of priority as follows:
The right choice of material (stainless steels and special materials, nonferrous metals such as copper, brass, bronze, aluminium or titanium and synthetic materials).
Subsequent surface coatings (lubrication, zinc coating, lacquering, phosphatizing, bronzing, chromizing, galvanizing)
Electro – chemical measures (cathodic protection)
Structural measures (insulation, avoidance of crevices etc.)
Knowing the right matings of material is certainly one of the relevant electro – chemical and structural measures. After all, the possibility of contact corrosion should always be considered when different metals are being used simultaneously in fastening elements and the elements earmarked for fastening.
The following overview provides reference values for suitable material matings as well as those that should be avoided.

Table corrosion protection

Table Corrosion Protectiopn

Material observed for contact corrosion	Area ratio to	Stainless steel	Copper	Tin	Lead	Chrome steel	Cast steel	Low alloy steel	Construction steel	Acid zinc coating	Aluminum alloy	Hot galvanized steel	Zinc	Magnesium alloy
Stainless steel	small			●	●		●	●		●	●	●	●	●
	Large		●	■	■	■	●	●	●	●	●	■	●	●
Copper	Small			▲	■	■		●	●	●	●	●	●	●
	Large	●		■	●		●	●	●	●	●	●	●	●
Tin	Small				●	●		●	●	●	●	●	●	●
	Large				●	■	●	●	●	●	●	●	●	●
Lead	Small		●	●		●	●	●	●	●	●	●	●	●
	Large	●		●		●	■	●	●	●	●	●	●	●
Chrome steel	Small	▲	▲	■	■			●	●	●	●	●	●	●
	Large	●		●	●			●	●	●	●	●	●	●
Cast steel	Small	▲	▲	▲	▲	▲		■	●	●	●	●	●	●
	Large			●	●	●		●	●	●	●	●	●	●
Low alloy steel	Small	▲	▲	▲	▲	▲	●		●	●	●	●	●	●
	Large	●	●	●	●	●	●		●	●	●	●	●	●
Construction steel	Small							■		●	●	●	●	●
	Large	●	●	●	●	●	●	●		●	●	●	●	●
Acid zinc coating	Small	▲	▲	▲	▲	▲	▲				●	●	●	●
	Large	●	●	●	●	●	●	●	●		●	■	●	■
Aluminium alloy	Small	▲	▲							●		●	●	■
	Large	■	▲	▲	▲	■	■	●	●	●		■	■	●
Hot galvanized steel	Small	▲	▲	▲	▲	▲	▲	▲	▲	■	■		●	■
	Large	●	●	●	●	●	●	●	●	●	●		●	●
Zinc	Small	▲	▲	▲	▲	▲	▲	▲	▲	■	■	●		■
	Large	●	●	●	●	●	●	●	●	●	●	●		●
Magnesium alloy	Small	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	
	Large	▲	▲	▲	▲	▲	▲	▲	▲	■	■	■	■	

Relation of the surface of the material observed (column) to the surface of the second material (line)

▲= heavy corrosion of the material observed

■= moderate corrosion of the material observed

●= slight or no corrosion of the material observed

STANDARDS FOR STAINLESS STEEL

British Standards

The British Standards in the table below are relevant to the design of stainless steel construction products.

Standards for Stainless Steel Fixings and Ancillary Building Components

Component	Standard	
Wall ties	BS 1243: 1978	Specification for metal ties for cavity wall construction
	BS 5628 Part 1 : 1992	Code of practice for masonry, structural use of unreinforced masonry
	BS 5628: Part 3: 2001	Code of practice for masonry: Materials and components, design and workmanship
	DD 140: Part 2: 1987	Recommendations for design of wall ties
Fixing for stone cladding	BS 8298: 1994	Code of practice for design and installation of natural stone cladding and lining
Straps and hangers	BS 5628: Part 3: 1985	Code of practice for masonry: Materials and components, design and workmanship
	BS 6178: Part 1: 1990	Specification for joist hangers for building into masonry walls of domestic buildings
Reinforcing bars	BS 6744: 1986	Specification for austenitic stainless steel bars for the reinforcement of concrete
Dowels	Highways Agency	Specification for highway works. Series 1700: Structural concrete
Lintels	BS 5977: Part 2: 1983	Specification for prefabricated lintels
Masonry support systems	BS 5628 Part 1 : 1992	Code of practice for masonry, structural use of unreinforced masonry
	BS 5628: Part 3: 2001	Code of practice for masonry: Materials and components, design and workmanship
	BS 8298: 1994	Code of practice for design and installation of natural stone cladding and lining
Fasteners	BS 6105: 1981	Specification for corrosion resistant stainless steel fasteners

SFSP

F.1 Stainless Steel Fasteners

Stainless steel fasteners are specified as BS EN ISO 3506. Part 1 covers bolts, screws and studs. Part 2 covers nuts. These specifications now replace BS 6105.

Grade A2 = 304 Grade A4 = 316

Mechanical Properties:

Property Class	Bolts, screws and studs		Nuts	Shear Strength of bolts in clearance holes Psb (N/mm²)
	0.2% Proof Stress RP 0.2 (N/ mm²)	Tensile Strength Rm (N/ mm²)	Proof Load Strength Sp (N/mm²)	
50	210	500	500	311
70	450	700	700	384

Designation:

A2 70

Austenitic Stainless Steel — Type — Tensile 1/10 of 700 MPa

Notes:

- *Property class 50 represents the steel in the annealed condition*
- *Property class 70 represents a "cold drawn" for the bar stock from which the fasteners are made.*
- *All tensile stress values are calculated and reported in terms of the nominal tensile stress area of the thread.*

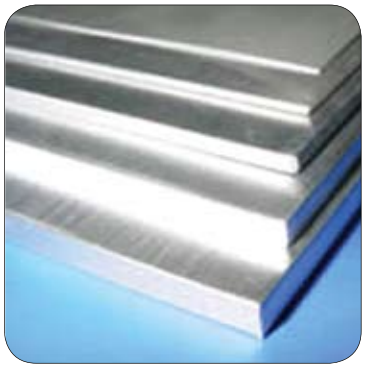
F.2 Austenitic Stainless Steel Wire

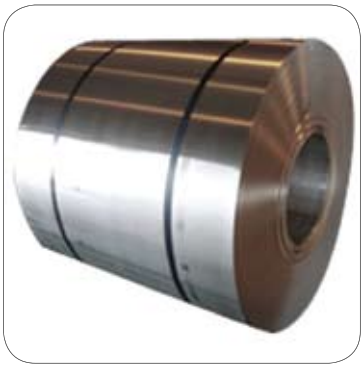
BS 1554 : 1991 min 18/8 , ASTM A276.

Bi – Metallic Contact:

When two dissimilar metals are in contact in the presence of an electrolyte, bi-metallic corrosion may occur. This may result in the corrosion of the base metal while the "noble" metal is protected.

The table indicates which metals may, in certain circumstances, be used together.





G- Aluminum 5052 & 6063

- Aluminum is one of the most abundant metals and therefore cost – efficient.
- High strength – to – weight ratio combined with extraordinary corrosion resistance and flexibility make aluminum a desirable solution to product design.

Aluminum Extrusions vs. Roll Formed Steel:

	Aluminum Extrusions	Roll Formed Steel
Strength (Tensile)	Very good mechanical properties	Very high mechanical properties
Density	Light weight: about 1/3 that of copper or steel	High density; high grams per cubic centimeter.
Strength-to-Weight Ratio	Very Good	Good
Corrosion Resistance	Excellent it can be further increased, along with enhanced appearance, through anodizing or other coatings.	Fair, usually requires protective coatings for corrosion service.
Formability	Easily formable and extruded in a wide variety of complex shapes including multi-void hollows. Formable to net shapes, and extrusions provide for the placement of metal where it's needed.	Readily formable; thinner cross-sections than aluminum extrusions; metal cannot always be located where best used in design.
Finishing	A huge array of finishes can be applied including mechanical and chemical pre finishes, anodic coatings, paints and electroplated finishes.	Protective coatings such as paint finishes are employed along with electroplated finishes.
Recyclability	High scrap value; routinely reprocessed to generate new extrusions.	Low scrap value.

Pure Aluminum has little strength, but possesses high electrical conductivity, reflectivity, and corrosion resistance. For these reasons, a wide variety of aluminum alloys have been developed.

Some Aluminum Alloys:

- 5052 Aluminum
- 6063 Aluminum

G.1- 5052 Aluminum

- 5052 is the alloy most suitable to forming operations, with good workability and higher strength than that of the 1100 or 3003 alloys that are commercially available.
- 5052 has very good corrosion resistance and can be easily welded. 5052 is not a good choice for extensive machining operations, as it has only a fair machinability rating.

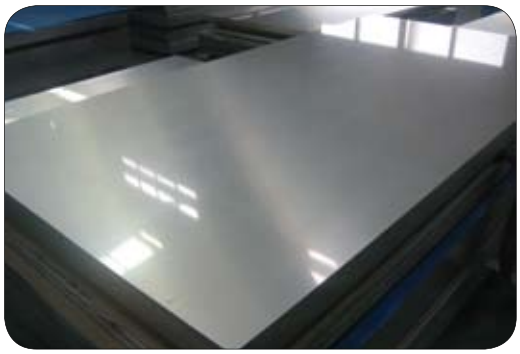
Grade Designation:

Aluminum 5052; UNS A95052; ISO AlMg 2.5

Specifications:

5052 – H32 Aluminum

Minimum Properties	Ultimate Tensile Strength , N/mm^2	230
	Yield Strength, N/mm^2	195
Chemistry	Aluminum (AL)	95.7 – 97.7 %



G.2-6063 Aluminum

- 6063 is often called architectural aluminum for two reasons: It has a surface finish that is far smoother than the other commercially available alloys. Its strength is significantly low (roughly half the strength of 6061), making it suitable for applications where strength is not the foremost consideration.
- 6063 is rated “Good” for forming and cold working operations, “Excellent” for anodizing and “Fair” for machining.

Grade Designation:

- Aluminum 6063-T6; UNS A96063; ISO AlMg 0.5Si.

Also corresponds to the following standard designations and specifications:

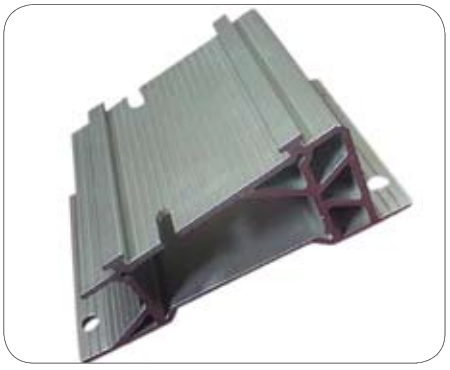
AA6063	ASTM	B361
GS10	ASTM	B483
A-GS	MIL	G – 18014
ASTM B210	MIL	P – 25995
ASTM B241	QQ	A – 200 / 9
United Kingdom		BS H19; DTD 372B
Germany		DIN AlMg Si 0.5 Werkstoff – Nr : 3.3206

Mechanical Properties:

		6063 – T6	6063 – T52
Ultimate Tensile Strength Tensile Yield Strength	N/mm^2 N/mm^2	240 215	185 145
Modulus of Elasticity Elongation at Break Fatigue Strength	N/mm^2 % N/mm^2	68,900 12 68.9	68,900 12 68.9
Machinability Shear Modulus Shear Strength	% N/mm^2 N/mm^2	50 25,800 150	----- ----- -----
Density Aluminum (Al) Content	g/cm^3 %	2.7 97.5	2.7 97.5

Conversion:

From	To	Multiply by
MPa	N/mm^2	1
GPa	N/mm^2	1000
N/mm^2	psi	145
GPa	ksi	145
MPa	psi	145
ksi	psi	1000
lb/in^3	g/cm^3	27.7



Surface Finish:

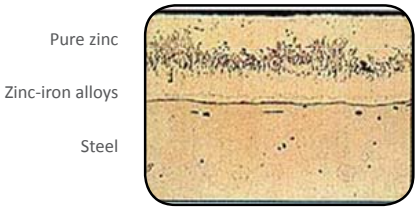
Natural metallic finish

FINISHES

1-Hot-Dip Galvanization (H.D.G) after Fabrication ISO 1461 / ASTM A 123

The H.D.G process consists of dipping steel in melted zinc at 450° Celsius temperature at which iron and zinc share great affinity, and allowing an alloy to form where pure zinc prevails to the outside.
Due to the difference of electrochemical potential between zinc and steel (cathodic protection), a zinc coating can protect steel in such a way that vigorous forces, such as cutting, scratching or piercing, are equally protected against corrosion.
What considerably affects the appearance and gauge of galvanization is the contents of alloyable elements that are generally present in steel: Carbon, magnesium, and silicon. If the contents of these elements increase, the coating gauge also increases and it becomes matte grey. The greatest effect is produced by silicon in concentrations higher than 0.12%.
(ISO 1459 with drown)

Section : through galvanized coating on silicon containing steel; Coating is zinc-iron alloy which appears gray.



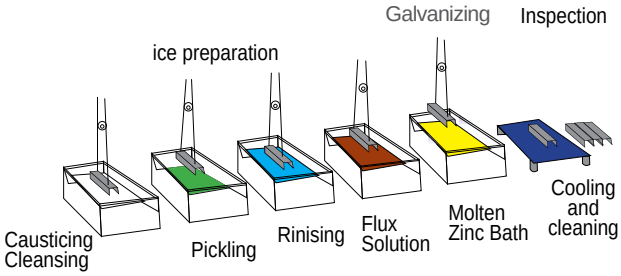
Section: through galvanized coating showing pure metal zinc and zinc-iron alloy layers which are the normal coating developments on rimmed or aluminium killed steel.

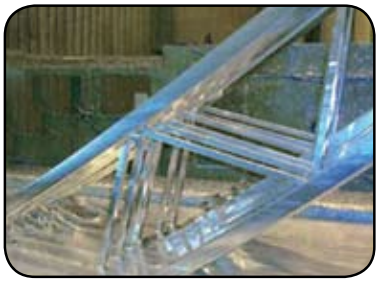
Hot Dip Galvanization Process:

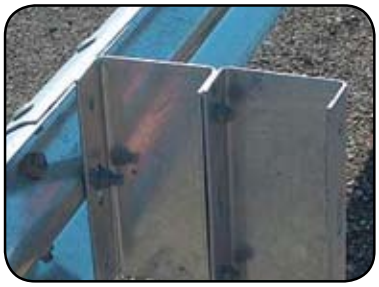
Minimum zinc weight / Comparison between various standards

Standard	Products to be Galvanized		Minimum Zinc Weight on each Specimen	
	Nature	Thickness (mm)	g/m²	Thickness (µm)
International Standard ISO 1461	Steel	e<1 1≤e<3 3≤e<5 e≥5	250 325 395 505	35 45 55 70
United States ASTM A-123	Steel	0.76≤e<1.6 1.6≤e<3.2 3.2≤e<6.4 e≥6.4	259 381 549 610	37 54 77 86
United Kingdom BS 729	Steel	1≤e<2 2≤e<5 e≥5	- - -	- - -
Germany DIN 50976	Steel	e<1 1≤e<3 3≤e<6 e≥6	325 360 430 540	45 50 60 75
European Standard CEN	Steel	e<1.5 1.5≤e<3 3≤e<6 e≥6	250 325 395 505	35 45 55 70
France NFA 91-121	Steel	e<1 1≤e<3 3≤e<5 e≥5	300 350 400 450	42 49 56 63
Italy UNI 5744	Steel	1≤e<3 3≤e<6 e≥6	360 470 540	50 65 75

Hot - Dip Galvanizing at SFSP







ASTM A 123 / A 123 M Requirements:

- **Coating Thickness / Weight:** dependent upon material category and steel thickness.
- **Finish:** continuous, smooth and uniform.
- **Appearance:** free from uncoated areas, blisters, flux deposits and gross dross inclusions as well as having no heavy zinc deposits that interfere with intended use.
- **Adherence**: the entire coating should have a strong adherence throughout the service period of galvanized steel.

Material Category	All Specimen Test Steel Thickness Range (Measured), in (mm)				
	<1.6 mm	1.6 to < 3.2 mm	3.2 to 4.8 mm	>4.8 to < 6.4 mm	≥ 6.4 mm
Structural Shapes and Plates	45	65	75	85	100
Strip and Bar	45	65	75	85	100
Pipe and Tubing	45	45	75	75	75
Wire	35	50	60	65	80

Table.1 Minimum Average Coating Thickness Grade by Material Category.

Table.2 Coating Thickness Grade

- The values in micrometer (µm) are based on the coating grade.
- The other values are based on conversions using the following formulas:
  - mils = µm x 0.03937; oz / ft² = µm x 0.02316.
  - g/m² = µm x 7.067; oz / ft² = g/m² x 0.00327.
  - 1 mil = 0.001 inch, 1µm = 0.001 mm = 0.00003937 inches.

Coating Grade	mils	oz / ft²	µm	g/m²
35	1.4	0.8	35	245
45	1.8	1.0	45	320
50	2.0	1.2	50	355
55	2.2	1.3	55	390
60	2.4	1.4	60	425
65	2.6	1.5	65	450
75	3.0	1.7	75	530
80	3.1	1.9	80	566
85	3.3	2.0	85	600
100	3.9	2.3	100	705

Table.2 Coating Thickness Grade.

Comparison Between ISO 1461 & ASTM A 123:

International Standards Organization (ISO) 1461, titled "Hot-Dip Galvanized Coatings on Fabricated Iron and Steel Articles-Specifications and Test Methods," is a general galvanizing specification.
This specification is essentially equivalent to the "American Society of Testing and Materials (ASTM) A123 and A153".

ISO steel thickness	ISO minimum average coating thickness	ASTM average minimum coating thickness
≥ 6 mm (~ ¼″)	3.3 mils (85 µm) local – steel. 3.1 mils (80 µm) – castings. 1.8 mils (45 µm) – castings (if centrifuged).	3.0 mils (76 µm) – pipe & tubing. 3.1 mils (79 µm) – wire. 3.3 mils (85 µm) – castings (ASTM A 153). 3.9 mils (99 µm) – structurals , strip & bar.
< 6 mm (~¼″) & ≥ 3 mm (~⅛″)	2.8 mils (70 µm) – steel & castings. 1.8 mils (45 µm) – castings (if centrifuged).	2.4-2.6 mils (61-65 µm) – wire. 3.0 mils (76 µm) - pipe & tubing . 3.0-3.3 mils (76-85 µm) – structurals, strip & bar. 3.3 mils (85 µm) – castings (ASTM A 153).
< 3 mm (~⅛″) & ≥ 1.5mm (~1/16″)	2.8 mils (70 µm) – castings. 2.2 mils (55 µm) – steel. 1.4 mils (35 µm) - casting (if centrifuged).	1.8 mils (46 µm) – pipe & tubing. 2.0 mils (51 µm) – wire. 2.6 mils (65 µm) - structurals, strip & bar. 3.3 mils (85 µm) – castings (ASTM A 153).
< 1.5mm (~1/16″)	2.8 mils (70 µm) – castings. 1.8 mils (45 µm) – steel. 1.4 mils (35 µm) - castings (if centrifuged).	1.4 mils (36 µm) – wire. 1.8 mils (46 µm) – pipe & tubing. 1.8 mils (46 µm) - structurals, strip & bar. 3.3 mils (85 µm) – castings (ASTM A 153).

Table.1 ISO 1461 vs. ASTM A 123/A 153 Coating Thickness Comparison.

ISO 1461 vs. ASTM A 153 Coating Thickness Comparison – Fasteners only:

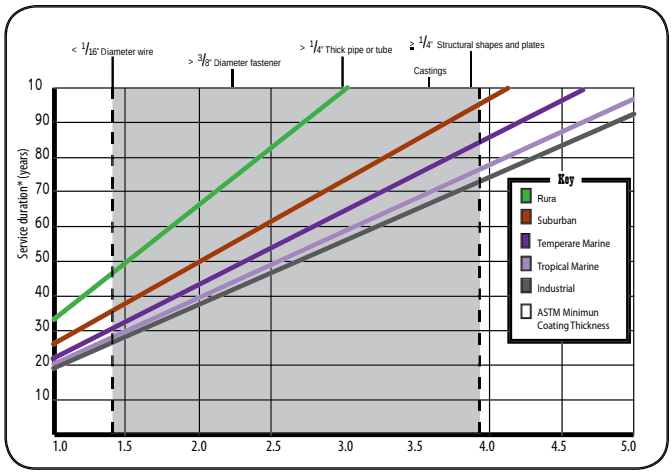
ISO steel diameter	ISO minimum average coating thickness	ASTM average minimum coating thickness
≥ 20 mm (~¾″)	1.8 mils (45 µm).	2.1 mils (54 µm).
< 20 mm (~¾″) & ≥ 6 mm (~¼″)	1.4 mils (35 µm) – w/ threads. 1.8 mils – w/o threads.	2.1 mils (54 µm) – over ⅜″ diameter. 1.7 mils (43 µm) – under ⅜″ diameter.
< 6 mm (~¼″)	0.8 mils (20 µm). 1.8 mils (45 µm)–w/o threads. over 3 mm diameter. 1.4 mils (35 µm)–w/o threads. under 3 mm diameter.	1.7 mils (43 µm).

There are no major differences between the two standards, ISO 1461 and ASTM A123.
mils = µm x 0.03937

Table 2. Differences Between ISO 1461 and ASTM A 123.

ISO 1461	ASTM A 123
Includes mention of Wet Storage – Not a Basis for rejection.	No Wet Storage stain mentioned.
Includes mention for ash as a basis for rejection when affecting intended use.	Ash not form of rejection.
Doesn't distinguish steel into material categories (i.e. Pipe, strip, wire).	Does categorize material by pipe, strip, and wire.
Bath composition – 98.5% Zn minimum / 1.5% additives by weight .	Bath Composition – 98% Zn by weight.
No adhesion testing suggested except visual inspection.	Adhesion testing – stout knife testing suggested.
Mean coating – average value on 1 large article or on all the articles in the control sample 5... Test readings per reference area (1,000 mm^2/min).	The average of three specimen coating thickness.
No thickness coating grade.	Has coating grade.
Designates coating thickness for castings.	No coating designation.
Renovation: • Uncovered areas by galvanizer shall not exceed 0.5%. • Each area shall not exceed 10 cm. • Min 12 mil (30µm) more than that required by coating requirements.	**Renovation:** Shall be 1 in (25 mm) or less in its narrowest dimension < ½ of 1% of the surface area or 36 m^2 (900 m^2) per ton of piece of weight, whichever is less 50% higher than (table 1), no more than 4.0 units.
Reference Area: • SA > 2 m^2 (large articles) at least 3 reference areas on each article in the control sample. • 10,000 mm^2 (SA) on each article in the control sample, one (at least) reference area. • 1,000 mm^2 – 10,000 mm^2 (SA) requires one reference area. • < 1,000 mm^2, group enough articles to form at least 1,000 mm^2 surface area for an individual reference area. (Table 1)	**Reference Area:** • SA > 160 m^2 (100,000 mm^2) (multi specimen) the average of the 3 specimen coating thickness grades comprising each test article is the average coating thickness for that test article. • SA ≤ 160 m^2 (single specimen), average of all specimens coating thickness grades is the average coating thickness for the sample. • Threaded components, the thickness of coating shall be made on a portion of the article that doesn't include any threads.
Testing Methods: Microscopic Method, Calculation and Magnetic Method.	**Testing Methods:** Magnetic Method, Stripping Method, Weighing before/after galvanizing Microscopy.
Renovation Methods: Shall be by zinc thermal spraying or by a suitable zinc rich paint. Use of zinc alloy stick is possible.	**Renovation Methods:** Thermal zinc spraying zinc rich paints and zinc alloy stick.
Dispute: Mean masses of HDG coating per unit area using gravimetric method and nominal density of the coating (7.2 g/ cm^2).	**Dispute:** New sample taken randomly from the lot, which has twice the % of the test articles. The sample is tested by Magnetic Thickness.

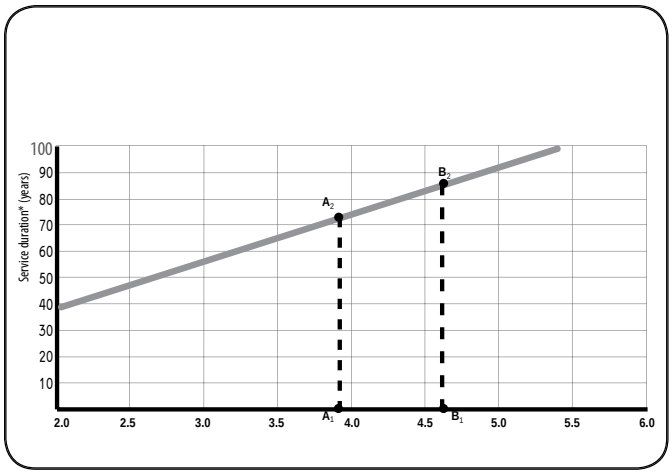
Service Duration Chart for Hot-Dip Galvanized Coatings



Average Thickness of zinc (mils)

*Service duration is defined as the time for 5% of the surface to rust. 1 mil=24.7µm /oz/ft^2 = 175g/m^2

Service Duration Chart for Hot-Dip Galvanized Coatings In an Industrial Environment



Average Thickness of zinc (mils)

*Service duration is defined as the time for 5% of the surface to rust. 1 mil=24.7µm /oz/ft^2 = 175g/m^2

Details:

Steel chemistry and surface condition determine the metallurgical reaction between zinc and iron (steel), therefore generating a range of zinc coating thicknesses.

Steel containing elevated amounts of silicon and phosphorus tend to exhibit thicker coatings. It is recommended that steels have a silicon content below 0.04% or between 0.15 % and 0.22%, as well as a phosphorus level less than 0.04%.

Notes:

A1: 1/4-inch thick steel has at least 3.9 mils (99 microns) of zinc coating, per ASTM A 123.

A2: 1/4-inch thick steel will be protected for approximately 72 years in an industrial environment before any touch-up or repair will be required to extend the life of the steel in use.

B1 and B2 : 1/2-inch thick steel often has a zinc coating of four mils or more, resulting in a maintenance-free performance for approximately 85 years.

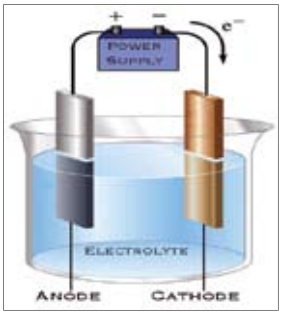
Cost: the initial cost of hot-dip galvanized steel is equal to the final cost, thus there are no maintenance costs from year 0 to year 72.

2-Zinc Electroplating after Fabrication /ASTM B633

- In the electroplating process, the part to be zinc coated is immersed in a solution of zinc ions.
- An electric current causes the zinc to be deposited on the part.
- Zinc plated parts typically have a zinc coating of 0.2 to 0.5 mil (5µm to 25 µm) and are recommended for dry indoor use.

Thickness Classes for Coatings for Zinc Plating		
Classification*	Service Condition**	Thickness Minimum µm (inch)
Fe / Zn 5	SC1 (mild)	5 (0.0002″)
Fe / Zn 8	SC2 (moderate)	8 (0.0003″)
Fe / Zn 12	SC3 (severe)	12(0.0005″)
Fe / Zn 25	SC4 (very severe)	25(0.001″)

* Iron or steel with zinc electroplate. Numerical thickness in micrometers
* * Where service conditions are valid only for coatings with chromate conversion coating.
Type II for SC4 and SC3 and type III for SC2 and SC1.



Zinc plated products have an attractive appearance when new as the zinc coating is bright and smooth, where a hot-dip galvanized coating has a duller and less smooth surface. There is typically about 10 times more zinc applied to small parts in the hot-dip galvanizing process as with zinc plating. But zinc plating will not provide adequate corrosion resistance and will rarely provide more than 12 months protection in most of the coastal population centers.

British Standards for Specifying Zinc Plating

Standard	Notes	Comments
BS EN 12329:2000 (Standard for zinc coating)	Coating requirements are specified by referencing the following codes or service conditions where the minimum zinc thickness is specified as a number e.g. ZN5 = 5 µm minimum thickness of zinc, and the passivate type or the supplementary treatment is called up by using the appropriate code. Typical thickness codes:ZN5,ZN8, ZN12, ZN25. **Passivate codes:** A = Clear passivate. B = Bleached passivate. C = Colored passivate. D = Olive drab passivate. F = Black passivate. **Supplementary treatment codes:** • T1 = Application of paints, varnishes, powder coatings or similar coatings materials. • T2 = Application of organic or inorganic sealants. • T3 = Dyeing. • T4 = Application of grease or oil or other lubricants. • T5 = Application of wax. **Example of full coating classification:** • Zinc plate to BS EN 12329:2000 FE//ZN8//A. Which means; FE = Ferrous substrate, ZN = Zinc coating 8 = 8 µm min deposit and A = Clear passivate.	Superseded BS 1706 :1990
BS 7371-12:2008 (Standard for imperial fasteners)	Thickness is dependent on service conditions, upon screw thread diameter and passivation called up by the ZN5 = 5 µm appropriate code. Screw thread dia / Batch av thk (µm): • 0.060″ to 0.125″ / 3.8 to 51 µm. • 0.126″ to 0.250″ / 5.1 to 6.4 µm. • 0.250″ to 0.500″ / 6.4 to 7.6 µm. • 0.500″ to 0.750″ / 7.6 to 8.9 µm. • >0.75″ **(See BS EN 12329)** **Passivate codes:** • A = Clear. B = Bleached. C= Color. D = Olive drab • BK = Black	Superseded BS 3385 (Part 2)
BS EN ISO4042:2000 (Standard for fasteners)	Painting thickness is dependent on thread diameter and passivation is called up by the appropriate code. Screw thread dia / Batch av thk (µm): • 1.0 to 2.0 mm / 3 • 2.5 to 8.0 mm / 5 • 10 to 16 mm / 8 • 18 to 22 mm / 10 > 22 mm **(See specification table).** **Passivate codes:** • Class 1: A = Clear. B = Bleached. • Class 2 : C = Color. D = Olive drab. BK = Black.	Replaces BS7371-3:(1993)

SFSP

Standards	Thickness
BS EN 12329:2000 FE / ZN SA	5 µm
BS EN 12329:2000 FE / ZN 12A & 12/C	12 µm
BS 1706 FE ZN 8c2c	8 µm
BS 1706 FE ZN 5c2c	5 µm
BS 3382 parts 1&2 1961	10 µm

Related Standards:

ISO 2081-NEQ, NF A91-052, DIN 50961, ASTM B633.

3-Powder Coating

- Epoxy coating powder types (EP).
- Polyester coating powder (SP).
- Polyester / Epoxy coating powder (SP / EP).

Epoxy Coating Powder Types (EP) (5-15 µm) / Internal:

EP coating powders possess very good chemical resistance and excellent mechanical values such as high elasticity or impact resistance. Epoxy powders are used for corrosion – resistant applications. They have no physiologically negative characteristics. One disadvantage is their tendency to " go chalky" and turn yellow under external factors

Polyester Coating Powder (SP) (25 µm) / External:

Polyester coating powders are weather proof and do not "go chalky", so they can be used out – doors. They have good mechanical properties such as blow and impact resistance and good adherence, which means that such later processes as sawing, drilling, or machining are also possible.

Polyester / Epoxy Coating Powder (SP / EP) / Internal & External:

- The mixing ratio between epoxy resin and polyester resin varies between 60 / 40 and 10 / 90. The resultant powder films are far more resistant to yellowing and less liable to "go chalky", and also was excellent mechanical qualities.

- The range of colours includes the whole of the standard RAL pallet and many others.

- The specific Gravity: range between 1.20 – 1.90 g/cm^3 depending on colour and type.

Technical Properties:

Item	Test Standard			Test Index
	ISO	UK	China	
Adhesion (Cross Cut)	ISO 2409	BS 3900 : Part E6	GB/T9286 -1998	Classification Gt0 – no loss of adhesion
Pencil Hardness	ASTM D3363	----	GB/T6739 -1996	1 H – 3H
Impact Test	ISO 6272	----	GB/T1732 -1993	10 – 60 kg cm
Erichsen Test	ISO 1520	BS 3900 : Part E4	GB/T9753 -1988	5 – 10 mm Depending on color and type
Flexibility	ISO 1519	BS 3900 : Part E1	GB/T6742 - 1986	0.5 – 2 mm

Chemical Resistance:

Excellent resistance against:

-Sea water.
-Tap water.
-Sulphuric Acid (20 %).
-Phosphoric Acid (30 %).
-Sodium hydroxide (30 %).
-Acetic Acid (20 %).
-High alcohols.

Limited resistance against:

-Hydrochloric Acid concentration.
-Nitric Acid (30 %).
-Petrol.
-Aromatic solvents.

RAL Colors:

RAL 1013 BEIGE	RAL 1003 YELLOW	RAL 3020 RED	RAL 8014 BROWN
RAL 9003 WHITE	RAL 7004 GREY	RAL 5015 blue	RAL 6005 GREEN

TERMS

- **AISI (American Iron and Steel Institute):** A North American trade association.

- **Alloying Element :** The adding of any metallic element in stainless steel production in order to increase hardness, strength or corrosion resistance. Molybdenum, nickel, and chromium are common alloying elements in stainless steel.

- **Alloy Steel (S):** Refers to steels made with deliberate additions of one or more alloying elements during steelmaking to enhance the properties of the steel. The most common alloying elements are Mn, Cr, Mo and Ni.

- **Annealing (Solution Annealing):** A process of heating cold stainless steel to obtain maximum softness and ductility by heat treatment which also produces a homogeneous structure (in austenitic grades). It relieves stresses that have built up during cold working and insures maximum corrosion resistance. Annealing can produce scale on the surface shall be removed by pickling.

- **Austenitic Stainless Steel:** Non-magnetic stainless steel that contain nickel and chromium. Austenitic stainless steels are the most widely used category of stainless steel.

- **Cold Forming (Cold Working):** Any mechanical operation that makes permanent deformation, such as bending, rolling, drawing, etc. performed at room temperature that increases the hardness and strength of the stainless steel.

- **Cold Roll Formed Sections (S):** The term usually refers to hot rolled steel that is roll formed cold into angles, channels or shaped / corrugated sheet. The word 'cold' refers to the forming process, not to the type of steel that is used.

- **Cold Rolled Strip (Sheet):** Stainless steel that has been run through a cold reduction mill.

- **Drawing (Drawn):** A forming process that presses metal into or through a die (as in cold drawn wire).

- **Ferritic:** Magnetic stainless steels that have a low carbon content and contain Chromium as the main alloying element, usually between 13% and 17%. It is the second most widely used stainless steel.

- **Ferrous:** Any metal that is primarily composed of iron.

- **Galvanneal (S):** Refers to a sheet steel product that is annealed after hot dip galvanizing with zinc. The additional annealing step produces an external zinc-iron alloy coating which gives the coated steel product exceptional corrosion resistance.

- **Gauge (S):** Another term for the thickness of sheet steel.

- **Hardness Test:** Hardness testing consists of pressing an indenter into a flat surface under a perfectly controlled load, then measuring the dimension of the resulting indentation.

- **HRC (S):** Common abbreviation for hot rolled coil.

- **Low-Carbon Stainless Steel:** Stainless steel containing less than 0.03% carbon.

- **Martensitic:** A small category of magnetic stainless steels typically containing 12% chromium, a moderate level of carbon and a very low level of nickel.

- **Mild steel (S):** Low carbon steel - often also referred to as soft steel. Carbon content generally under 0.25%.

- **Molybdenum (Mo):** An alloying element that enhances corrosion resistance along with chromium in stainless steels.

- **Nickel (Ni):** An alloying element used in stainless steels to enhance ductility and corrosion resistance.

- **Non-Ferrous Metal:** Metal or alloy that contains no iron.

- **Passivation:** When exposed to air, stainless steels passivate naturally (due to the presence of chromium). In order to ensure that the passive layer reforms rapidly after pickling, a passivation treatment is performed using a solution of nitric acid and water.

- **Pickling:** A process that removes surface scale and oxidation products by immersion in a chemically active solution, such as sulfuric or hydrochloric acid.

- **Quenching (S):** Rapid cooling - typically undertaken to obtain a specific property such as increased hardness of steel.

- **Secondary Stainless Steel:** Stainless steel that has been rejected by an original customer because of a defect in the chemistry, gauge or surface quality.

- **Stainless Steel:** Group of corrosion resistant steels containing at least 10.5% chromium and may contain other alloying elements; These steels resist corrosion and maintain its strength at high temperatures.

- **Titanium (Ti):** A very ductile and malleable white metal that is used in aviation, aerospace, etc. because of its high strength and light weight.

- **Tungsten (W):** Gray metal with high tensile strength. It is ductile, malleable, and resistant to atmospheric elements and all acids except strong alkalies.

- **Impact Strength:** Absorbed energy is designated by KV, in V-notch and Ku in u notch.

- **Tempering:** Process of giving the requisite degree of hardness or softness to steel.

- **Chromating:** the process of covering a surface with an oxide layer that chemically reacts to form metal chromates.

NOTES