HALFEN CAST-IN CHANNELS
TECHNICAL PRODUCT INFORMATION

HALFEN CAST-IN CHANNELS

CONCRETE

B 17-E_SEA

HALFEN IQ
INTEGRATED QUALITY

DYNAGRIP
The most advanced channel generation

EPD – Environmental product declaration
HTA-CE / HZA

HALFEN
YOUR BEST CONNECTIONS

HALFEN.
When safety counts.

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Marina Bay Sands, Singapore

FIXING SYSTEMS, FRAMING SYSTEMS AND ACCESSORIES

HTA-CE
Cast-In Channels

HZA –
DYNAGRIP Cast-In Channels

HTA-CS –
Curved Solution Channels

HGB –
Balustrade Fixings

HTU Cast-In Channels

DEMU
Sockets/Inserts

HB
Anchor bolts

HALFEN Framing Channels and HALFEN Bolts

HALFEN Framing System/ Accessories

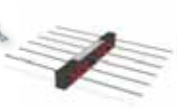
REINFORCEMENT SYSTEMS

HBS-05
Screw Connections

MBT
Reinforcement Couplers

HBT
Rebend Connections

HDB
Shear Rails



HIT
Insulated Connections

HBB
bi-Trapez-Box®

HTT/HTF
Impact Sound Insulation Elements

HCC
Column Shoe

HSC
Stud Connector

LIFTING SYSTEMS, CONCRETE PRE-CAST SYSTEMS, NATURAL STONE SYSTEMS, BRICKWORK SUPPORT SYSTEMS, ROD SYSTEMS

DEHA KKT
Spherical Head Lifting Anchor

DEHA HA
Socket Anchor

DEHA HD-Socket Lifting Anchor System

FPA
Precast Panel Anchors

MVA
Sleeve Sandwich Panel Anchors

BA
Body Anchor

UMA
Grout-In Anchors

SUK
Sub Structure

HK5
Brickwork support system

DETAN
Tension Rod System

HALFEN products are typically the first choice for project investors, architects, engineers or construction companies whenever high quality products made from the best materials, sustainability, versatility and economical speed are the dominating project features. HALFEN symbolizes safety, reliabilty and efficiency.

HALFEN
YOUR BEST CONNECTIONS

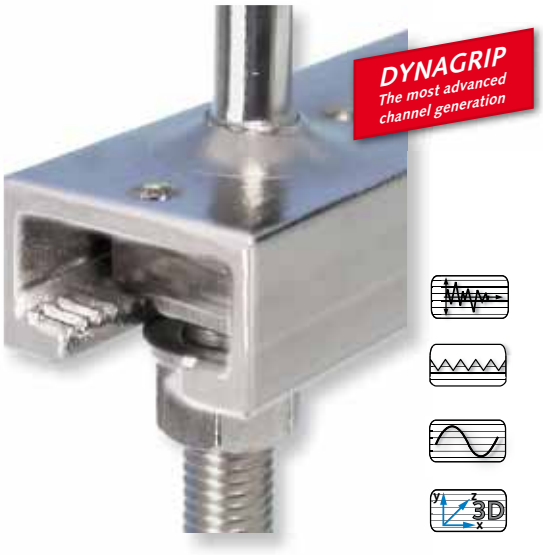
HALFEN CAST-IN CHANNELS

Contents

Overview

HZA DYNAGRIP, hot-rolled

- sharp-edged profiles
- free from inherent stress
- innovative serration on channel lips and T-bolt heads provides additional mechanical interlock connection
- uniform load bearing capacity in all load direction
- highest dynamic loading
- suitable for shock loads
- suitable for seismic loading
- National Approval (DIBt, Germany)



HTA-CE, hot-rolled

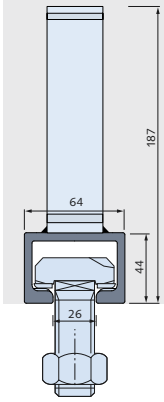
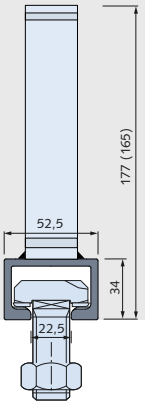
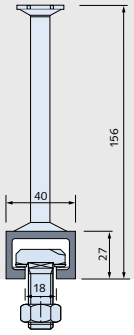
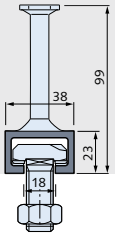
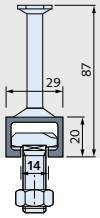
- sharp-edged profile rolled from steel billet
- free from inherent stress
- optimized geometry according to static requirements
- approved for dynamic loading
- 30 % increased shear resistance and up to 75 % increased resistance against local flexure of channel lips compared to cold-formed alternatives
- increased fire resistance
- suitable for shock loads
- European Technical Approval (ETA)
- National Approval (DIBt, Germany)

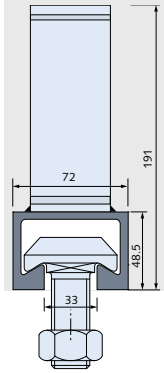
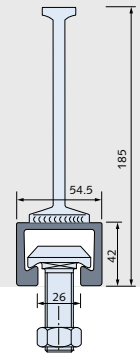
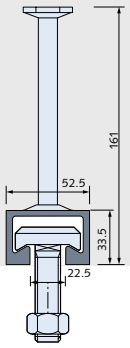
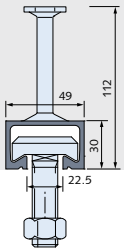
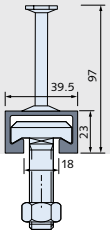
HTA-CE, cold-formed

- rounded corners, constant material thickness
- smooth surface finish
- European Technical Approval (ETA)
- National Approval (DIBt, Germany)

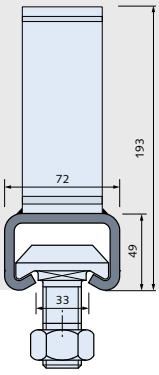
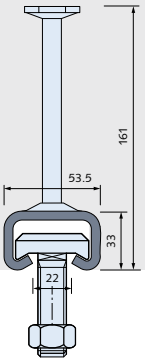
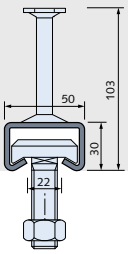
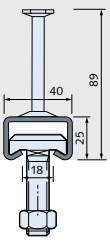
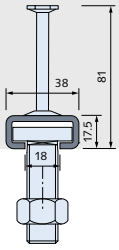
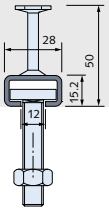
HALFEN CAST-IN CHANNELS

Overview

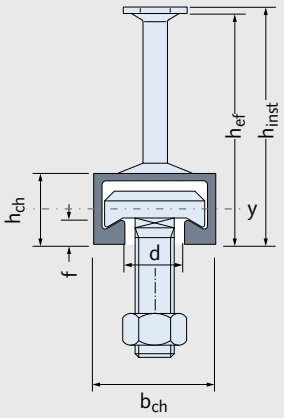
HZA 64/44		HZA 53/34	HZA 41/27	HZA 38/23	HZA 29/20
$N_{Rd} = V_{y,Rd} = V_{x,Rd} =$ 37.8 kN		$N_{Rd} = V_{y,Rd} = V_{x,Rd} =$ 30.8 kN	$N_{Rd} = V_{y,Rd} = 28.0$ kN $V_{x,Rd} = 16.8$ kN	$N_{Rd} = V_{y,Rd} = V_{x,Rd} =$ 16.8 kN	$N_{Rd} = V_{y,Rd} = V_{x,Rd} =$ 11.2 kN
					
HZS 64/44 M20–M24		HZS 53/34 M16–M20	HZS 38/23 M12–M16	HZS 38/23 M12–M16	HZS 29/20 M12

HTA-CE 72/48	HTA-CE 55/42	HTA-CE 52/34	HTA-CE 50/30 P	HTA-CE 40/22 P
$N_{R\,d} = 55.6$ kN $V_{y,Rd} = 72.2$ kN	$N_{Rd} = 44.4$ kN $V_{y,Rd} = 57.8$ kN	$N_{Rd} = 36.1$ kN $V_{y,Rd} = 39.7$ kN	$N_{Rd} = 21.7$ kN $V_{y,Rd} = 22.4$ kN	$N_{Rd} = 19.4$ kN $V_{y,Rd} = 19.4$ kN
				
HS 72/48 M20–M30 HSR 72/48 M20	HS 50/30 M10–M24 HSR 50/30 M16–M20	HS 50/30 M10–M20 HSR 50/30 M16–M20	HS 50/30 M10–M20 HSR 50/30 M16–M20	HS 40/22 M10–M16 HSR 40/22 M16

HTA-CE 55/42 and 52/34 are available with weld-on or bolt anchors.

HTA-CE 72/49		HTA-CE 54/33		HTA-CE 49/30	HTA-CE 40/25	HTA-CE 38/17	HTA-CE 28/15
$N_{Rd} = 55.6$ kN $V_{y,Rd} = 55.6$ kN		$N_{Rd} = 30.6$ kN $V_{y,Rd} = 30.6$ kN		$N_{Rd} = 17.2$ kN $V_{y,Rd} = 17.2$ kN	$N_{R,d} = 11.1$ kN $V_{yR,d} = 11.1$ kN	$N_{R,d} = 10.0$ kN $V_{yR,d} = 10.0$ kN	$N_{R,d} = 5.0$ kN $V_{yR,d} = 5.0$ kN
							
HS 72/48 M20–M30		HS 50/30 M10–M20		HS 50/30 M10–M20	HS 40/22 M10–M16	HS 38/17 M10–M16	HS 28/15 M6–M12

HALFEN Cast-in channels Legend – dimensions



Legend

h_{inst}: max. installation height
h_{ef}: effective anchorage depth
h_{ch}: channel height
b_{ch}: channel width
y: centre line
d: channel slot width
f: max. height of channel lip

Technical Remarks

- load capacities based on steel failure
- alternative anchor configuration available on request

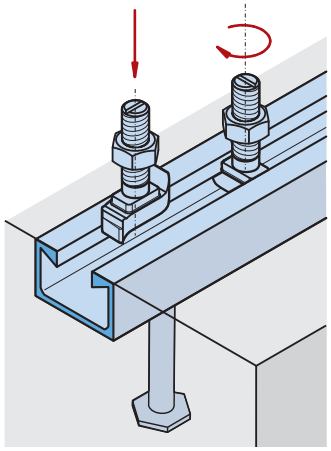
The advantages at a glance

... by use of HALFEN Cast-in channels

- extreme short installation time
- installations are freely adjustable along the channel slot (compensation of construction tolerances)
- only simple tools and no electrical power required for installation
- installer requires no special training
- components (channels, bolts) protected against corrosion by high-quality galvanized finish or stainless steel
- serrated hot-rolled channels with high resistance to dynamic, impact and seismic loads
- certified for use in fire-critical structural elements
- can be used for temporary installations, e.g. guard railing
- easy visual installation check (QC) on site
- increased site productivity with reduced manpower

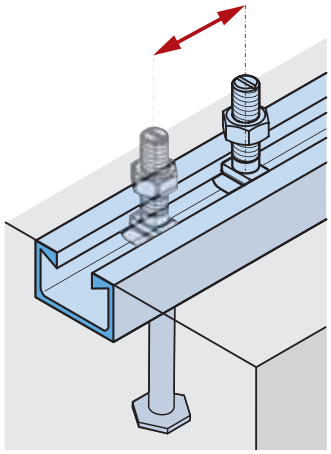

Modular panel installation


Panel positioning


Fast installation


Curved channels in tubbing segments, Shenzhen metro


Mullion fixing at front of slab


Full adjustability


Adjustable fixing


Tightening the T-bolt

Hidden dangers to be aware of

…when using welding plates

- slow installation
- welding sparks and fumes can cause fire!
  (→ bamboo scaffolding, safety net)
- satisfactory welding quality is difficult to achieve and check;
  depends largely on the individual welders ability
- fumes may damage installed aluminium and glass
  → costly damage
- limited adjustability
- requires project specific design, testing and inspection
- corrosion protection after welding required
- heavy electrical equipment necessary
- inflexibility in case of change requests

…when using mechanical or chemical anchor bolts

- time consuming and strenuous, repetative drilling and bolt setting,
  particularly in high-strength concrete
- non adjustable
- high risk of damage to reinforcement and concrete
- potential damage to tendons in pre-stressed slabs
- drill holes may be incorrectly located or too large
  due to inaccurate drilling or worn drill-bits
- wrong location of anchor bolts may lead to unfavourable need for
  additional clamping plates
- risk that the anchor bolts are not suitable for cracked concrete,
  dynamic loading or for use in earthquake zones
- repeated use of hammer drills can result in a range of health problems;
  known as hand-arm vibration syndrome (HAVS) with symptoms like vibration
  white finger (VWF).
- hammer drilling causes vibration, which may result in concrete cracks
  of undefined width and length
- numerous installation steps - each individual step is a possible source
  for human error (in particular with chemical bolts)
- proper on site visual installation check (QC) is not possible

Vibration White Finger (VWF)

Approvals & Test Reports

- **German National Approval by DIBt**
  HALFEN Cast-in channels are regularly tested at German universities and independent material testing authorities. HALFEN HTA Channels were first awarded a National approval in 1976; the first ever for a cast-in channel.
- **European Technical Approval ETA**
  Obtained in 2010, this approval for HTA-CE Channels is valid unrestrictedly in 30 European states and is recognized worldwide.
- **Tongji University Shanghai – Expert reports**
  Anchor channels have been tested in concrete under static loading as well as under seismic loading in cracked concrete.
- **China Academy of Building Research (Beijing) – Test reports**
  In-situ testing of the entire cast-in channel range under static loading at the "National Center for Quality Supervision and Test of Building Engineering".
- **American National Approval by the ICC**
  ICC-ES evaluation report ESR-1008 - HALFEN Anchor channels and bolts in cracked and uncracked concrete; issued 04/2016.
  ICC-ES evaluation report ESR-4016 - HALFEN HZA Anchor channels and HZS Channel bolts in cracked and uncracked concrete; issued 06/2017.

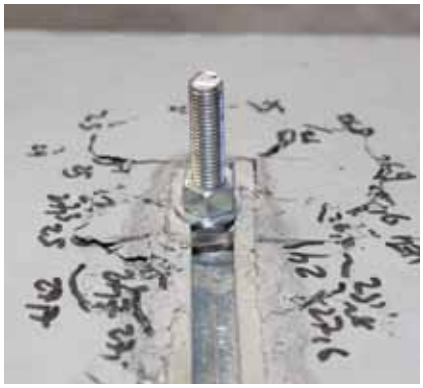
officially App. No Z - 21.4 approved

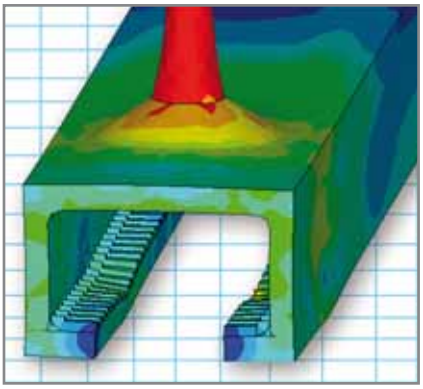
CE ETA - 09 / 0339 432-CPD-8394-01

ICC-ESR 1008
ICC-ESR 4016

DYNAGRIP product testing at RWTH Aachen university

Formwork and reinforcement of test specimen with HZA 38/23


Concrete spalling on surface under tension loading


Qualitative deformation figure for tension load from a computer simulation

Sustainability

HALFEN is a socially and environmentally responsible company. The issues of sustainability, protection of the environment and the reduction of CO_2 emissions are very important issues for us. During the BAU 2017 trade fair the Institut für Bauen und Umwelt e.V. (IBU) presented HALFEN with a EPD declaration for the original HALFEN Channel and the HALFEN HIT Insulated connection.

Enviromental Product Declaration HTA-CE and HZA

An EPD® (Environmental Product Declaration) provides transparent and comparable ecological data which helps to evaluate the sustainability of a building. EPDs form the data basis for an environmental building assessment in accordance with DIN EN 15978.
The declarations are internationally coordinated; they are based on international standards (ISO 14025; ISO 14040ff) – as well as on European DIN EN 15804.
The EPD - declaration for the HALFEN Channels HTA-CE and HZA was presented by the Institut für Bauen und Umwelt e.V. (IBU) during the BAU 2017 Trade fair.

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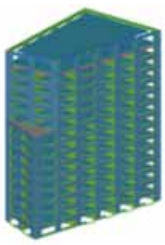
BIM

HALFEN is your partner for BIM (Building Information Modeling), the working method aimed at facilitating exchange and interoperability of digital information in building projects, and as such provides their (Tekla) components through 3D BIM libraries.
A BIM model is a single model (database) in which information from architects, structural engineers, installers, contractors and suppliers is processed. The information relates to shape (geometry) and behaviour (object properties).

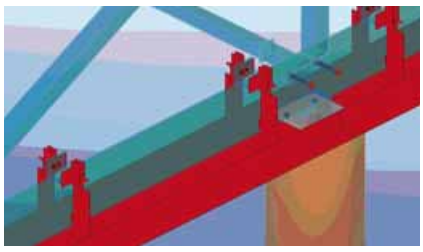
Working in a 3D environment makes it easy to generate sections or visualizations, for example in a complex junction floor, balcony, brickwork support, etc. Other benefits include reducing failure costs, better quality of the building and promoting cooperation and mutual understanding between all parties.

For anchoring façades (for example brickwork support) HALFEN uses the Open BIM philosophy: a universal cooperation, exchange and communication method based on the open file formats (IFC), a format that doesn`t require using specific software, because:

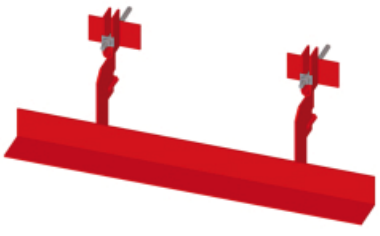
- IFC is the most used and most developed open standard for BIM models
- HALFEN will not exclude other companies using other BIM applications
- More and more clients will require BIM “as built” according to open standards



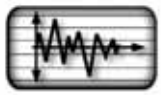
BIM project

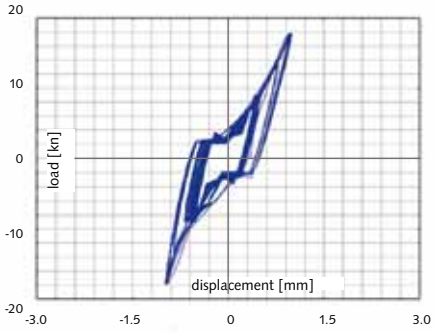


BIM detail



BIM component





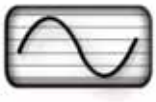
Load-displacement curve of cyclic loading (SQ 3)

Performance under seismic loading

The serrated anchor channels have been tested according to the requirements of ACI 355.2-2007. This standard is internationally recognized for post installed anchors and was applied with minor modifications to the anchor channels. According to the ACI 355.2-2007 test procedure, a specimen must withstand 140 load cycles without failure. These tests were carried out at the University RWTH Aachen/Germany (HZA 29/20, HZA 38/23 and HZA 53/34) and at the Tongji University in Shanghai (HZA 41/27).

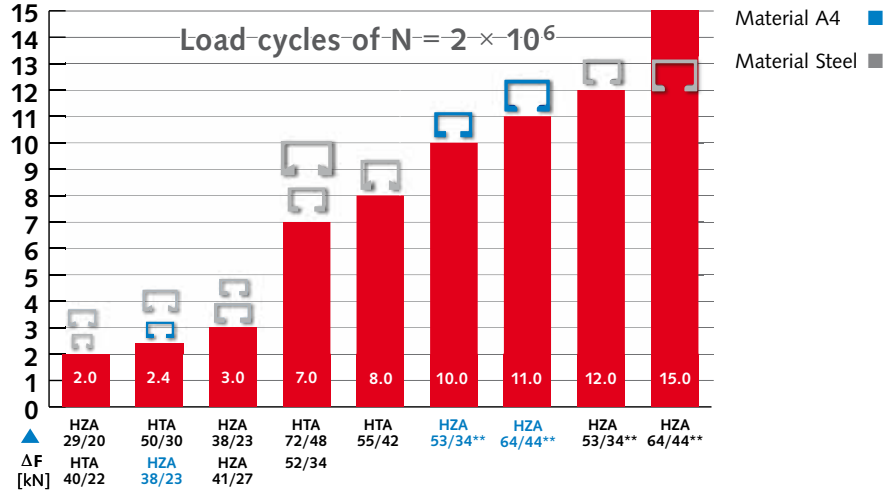
The load cycles are applied in three consecutive load steps whereas the test loads N_{eq} and V_{eq} are derived from static reference tests.
After cyclic loading the anchor channels are subjected to a static, increasing load up to breaking point. The average remaining load bearing capacity must be:
> 1.6 × N_{eq} (tension) respectively **> 1.6 × V_{eq}** (shear)**.**

The test results verified that the design resistance values F_{Rd} stated in the HZA-Approval certificate no.Z-21.4-1691 are also valid for the load resulting from an earthquake.



Performance under dynamic loading

Dynamic load capacity/fatigue for HTA/HZA



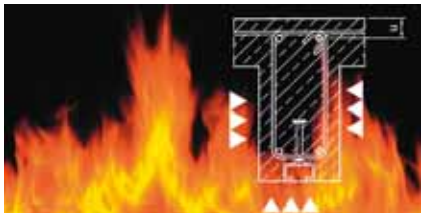
Legend:

(Load) amplitude ΔF * [kN]
* Steel failure decisive

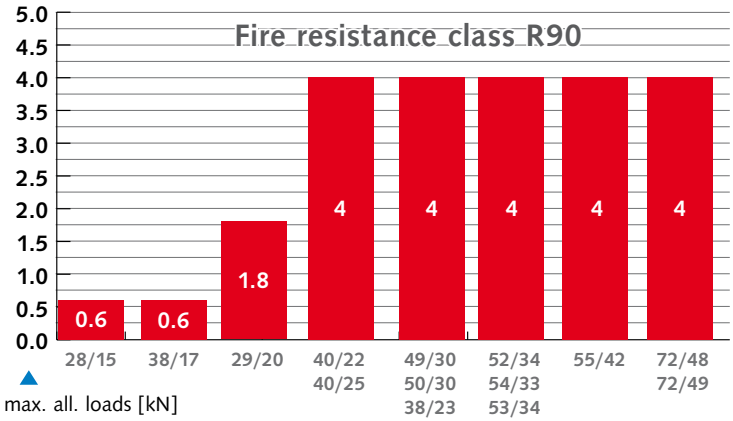
According to German National Approval

** Values apply for channels with l-anchors 140/7,1, anchor position Q, longitudinal weld seam

Fire resistance



HALFEN Cast-in channels HTA and HZA, in combination with HALFEN Bolts, have been certified for use in fire-exposed structural elements (R90/R120).



R120 fire resistance ratings can be found in ETA-09/0339, Annex 18 (Tension loads) and Annex 19 (Shear loads).

HALFEN Quality – from start to finish

Quality and safety are the ultimate targets in the production of original HALFEN Anchor channels.
The fundamental requirements for the production of any HALFEN product are quality and safety. Therefore all HALFEN production locations are ISO 9001 certified.

On the one hand this involves continual inspection, machine maintenance and quality testing during the manufacturing process and on the other hand it involves stringent quality control procedures of incoming raw materials right through to dispatch of the finished product.

QUALITY SYSTEM CERTIFICATION
DNV·GL
ISO 9001

Cert.-No.
202384-2016-AQ-GER-DAkkS

Quality always comes first for HALFEN products and is guaranteed during each step of production!
Non-serrated channels, type HTA-CE are European Technical Approved (ETA 09/0339). HALFEN Cast-in channels have also been approved by the German Construction Supervisory Board – DIBt Berlin and are subject to stringent internal and external quality checks.
The extent, type and frequency of production checks carried out by HALFEN is determined by standards set and recorded in approvals by the German Construction Supervisory Board DIBt (member of EOTA – European Organization for Technical Approvals).


Spectral analysis equipment

HALFEN Anchor channels, originating exclusively from our own production facilities, are produced of strictly regulated raw material. The complete raw material or semi-finished goods are procured solely from resources that meet our stringent in-house material specifications.

Our suppliers must be ISO 9001 certified and must provide complete documentation on the required performance and quality. Therefore, our suppliers have to prove compliance with our material specifications with a 3.1 inspection certificate according to DIN EN 10204.

The inspection of incoming material is not limited to visual examination and dimensional checks. Every consignment is also analysed via spectral analysis. Moreover, the required tensile strength values, yield stress and rupture points are tested.

Raw material is released for production only if all tests results are satisfying and comply with the provided 3.1-certification.
The anchor channels are continually checked during production for dimensional precision. The required frequency for measurement is set in our quality control procedures.

At the end of the production process, before dispatch or storage, our QM regulations require visual checks, dimensional control and tensile tests on a predetermined percentage of finished products. All tested anchor channels must prove a minimum safety factor against steel failure.

We commission regular, basis steel tests as defined in the DIBt requirements.


Dimensional inspection

The HALFEN management ensures the complete process chain, from the receipt of the raw material until final delivery of the finished products, are controllable and traceable. Therefore, complete traceability and a guarantee of the required performance and quality can be provided for all HALFEN products.

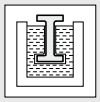
We at HALFEN are fully aware of our responsibility and will continue to maintain our excellent reputation with high quality products!

HALFEN IQ
INTEGRATED QUALITY

Materials / Corrosion Protection

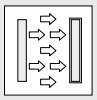
Steel – Hot-dip galvanized FV (HDG):

Steel parts dipped in a bath of molten zinc at approx. 460°C, forming an alloy layer between zinc coating and base metal.

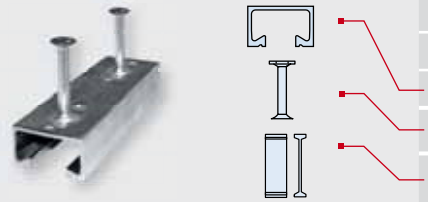


Steel – Special thick layer passivation GVs:

Electrolytic application of zinc applying a thick layer of pure zinc with special passivation.



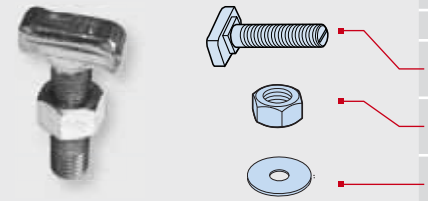
HALFEN Cast-in channels, steel, hot-dip galvanized



	Steel		
	Material	Standard	Zinc coat ②
Channel profile	1.0038 / 1.0044 ☐	DIN EN 10 025-2 ①	FV: ≥ 55 µm
Bolt anchor B6	Steel ☐	DIN EN 10263 or DIN EN 10269	FV: ≥ 55 µm
Weld-on anchor	Steel ☐	DIN EN 10 025-2	FV: ≥ 55 µm

① Steel according to DIN EN 10 025-2 and HALFEN specification ② values are minimum values. mean values are considerably higher

HALFEN Bolts, galvanized steel



	Steel		
	Material	Standard	Zinc coat ②
Bolt	Steel grade 4.6 or 8.8 ☐ ☒	DIN EN ISO 898-1	FV: ≥ 50 µm GVs: ≥ 12 µm
Hexagonal nut	Steel grade 5 or 8 ☐ ☒	DIN EN ISO 898-2	FV: ≥ 50 µm GVs: ≥ 12 µm
Washer	Steel ☐ ☒	DIN EN ISO 7089, 7093	FV: ≥ 50 µm GVs: ≥ 12 µm

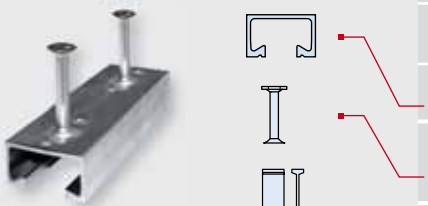
Stainless steel A4:

Chromium is the most important alloy element in stainless steel. A specific chromium concentration ensures the generation of a passive layer on the surface of the steel that protects the base material against corrosion. This explains the high corrosion resistance of stainless steel.

Materials / Surface finish

- ☐ **WB** = Steel mill finished (MF)
- ▒ **FV** = Steel hot-dip galvanized (HDG)
- ☒ **GVs** = Steel zinc galvanized (with special coating)
- ▒ **A4** = Steel, stainless 1.4571 / 1.4404 / 1.4578
- ☒ **HCR** = Steel, stainless 1.4547 / 1.4529

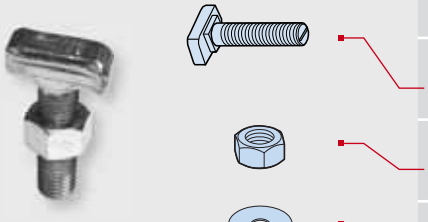
HALFEN Cast-in channels, stainless steel



	Stainless steel		
	Material	Standard	Corrosion resistance class ②
Channel profile	1.4404 or 1.4571 ▒	DIN EN 10 088	III
	1.4529 or 1.4547 ☒		V
Bolt anchor B6	1.4404, 1.4571 or 1.4578 ▒	DIN EN 10 088	III
	1.4529 or 1.4547 ☒		V
Weld-on anchor	1.4404 or 1.4571 ▒	DIN EN 10 088	III
	Steel ③	DIN EN 10 025-2	

② See EN 1993-1-4, table A.3 ③ Corrosion protection of mill finished anchor, see page 13

HALFEN Bolts, stainless steel



	Stainless steel		
	Material	Standard	Corrosion resistance class ②
Bolt	1.4404, 1.4571, 1.4578 (A4-50 or A4-70) ▒	DIN EN 3506-1 and DIN EN 10 088	III
	1.4529, HCR-50 ☒	DIN EN 3506-1	V
Hexagonal nut	1.4404, 1.4571, 1.4578 (A4-50, A4-70) ▒	DIN EN 3506-2 and DIN EN 10 088	III
	1.4529, HCR-50 ☒		V
Washer	1.4404, 1.4571 ▒	DIN EN 10 088	III
	1.4529 or 1.4547 ☒		V

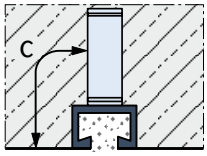
② See EN 1993-1-4, table A.3

Corrosion protection requirements – Material and applications				
	1	2	3	4
Description	**Dry interior-rooms**	**Damp interior-rooms**	**Medium corrosion level**	**High level of corrosion**
Definition of application areas	Anchor channels may only be used in components in indoor environments. **For example:** living and office spaces, schools; hospitals, commercial shops with the exception of wet rooms as in column **2**.	Anchor channels may also be used in components in areas with normal humidity **For example:** kitchens, bathrooms and laundry-rooms in residential buildings. Exceptions: where permanent steam is present and under water.	Anchor channels may also be used in outdoor environments (including industrial environments and coastal regions) or in wet rooms, if conditions are not especially aggressive (for example: continual immersion in sea water etc. as in column **4**).	Anchor channels may also be used in exceptionally aggressive environments (for example: continual immersion in sea water) or in seawater spray zones, chloride environments in swimming pools or in environments with an extremely aggressive chemical atmosphere (for example: flue gas desulphurization plants or road tunnels where de-icer systems are in use).
Channel profile	Steel 1.0038, 1.0044; EN 10025 Hot-dip galvanized ≥ 55 µm ⑥	Steel 1.0038, 1.0044; EN 10025 Hot-dip galvanized ≥ 55 µm ⑥ Stainless steel 1.4307, 1.4567, 1.4541; EN 10088	Stainless steel 1.4404, 1.4571, 1.4062, 1.4162, 1.4362 EN 10088	Stainless steel 1.4462 ②, 1.4529, 1.4547 EN 10088
Anchor	Steel 1.0038, 1.0214, 1.0401, 1.1132, 1.5525; EN 10263, EN 10269 Hot-dip galvanized 55 µm ⑥	Steel 1.0038, 1.0214, 1.0401, 1.1132, 1.5525; EN 10263, EN 10269 Hot-dip galvanized ≥ 55 µm ⑥ Stainless steel 1.4307, 1.4567, 1.4541; EN 10088	Stainless steel 1.4404, 1.4571, 1.4362, 1.4578 EN 10088 Mill finish, 1.0038 ③	
Special HALFEN Bolts with shaft and screws in accordance with EN ISO 4018	Steel strength class 4.6 / 8.8 EN ISO 898-1 Zinc galvanized ≥ 5 µm ④	Steel strength class 4.6 / 8.8; EN ISO 898-1, Hot-dip galvanized ≥ 50 µm ① ⑤ Stainless steel, strength class 50, 70 1.4307, 1.4567, 1.4541 EN ISO 3506-1	Stainless steel Strength class 50, 70 1.4404, 1.4571, 1.4362, 1.4578 EN ISO 3506-1	Stainless steel Strength class 50, 70 1.4462 ②, 1.4529, 1.4547 EN ISO 3506-1
Washers EN ISO 7089 and EN ISO 7093-1 Product classification A, 200 HV	Steel EN 10025 Zinc galvanized 5 µm ④	Steel EN 10025 Hot-dip galvanized ≥ 50 µm ① ⑤ Stainless steel Steel grade A2, A3; EN ISO 3506-1	Stainless steel Steel grade A4, A5 EN ISO 3506-1	Stainless steel 1.4462 ②,1.4529, 1.4547 EN ISO 3506-1
Hexagonal nut EN ISO 4032	Steel strength class 5/8 EN ISO 898-2 Zinc galvanized 5 µm ④	Steel strength class 5/8 EN ISO 898-2 Hot-dip galvanized ≥ 50 µm ① ⑤ Stainless steel, strength class 70, 80 Steel grade A2, A3 EN ISO 3506-2	Stainless steel Strength class 70, 80 Steel grade A4, A5 EN ISO 3506-2	Stainless steel Strength class 70, 80 1.4462 ②, 1.4529, 1.4547 EN ISO 3506-2

① or zinc galvanized with special coating ≥ 12 µm
② 1.4462 not suitable for swimming baths (see Eurocode EC3 part 1-4 table A.4)
③ Steel in accordance with EN 10025, 1.0038 not for Anchor channels 28/15 and 38/17
④ Zinc galvanized in accordance with EN ISO 4042
⑤ Hot-dip galvanized in accordance with EN ISO 10684
⑥ Hot-dip galvanized in accordance with EN ISO 1461

Concrete cover: Corrosion protection evaluation for mill finished weld-on anchors is based on the following concrete cover c.

Profile	38/23	50/30P 52/34 53/34	55/42 64/44	72/48
Concrete cover c [mm]	30	40	50	60



Concrete cover c

Hot-dip galvanized coatings

Coatings applied by hot-dip galvanizing are designed to protect the steel against corrosion, the length of time of corrosion protection by such coatings is proportional to the coating thickness!
Guaranteed **minimum** local coating thickness for HALFEN products:
HALFEN Cast-in channels, finish FV (HDG): **55 µm**
HALFEN T-bolts, finish FV (HDG): **50 µm**

Coating thickness is sometimes provided as mean (average) coating thickness. A **minimum** local coating thickness is considerably smaller than a mean coating thickness!

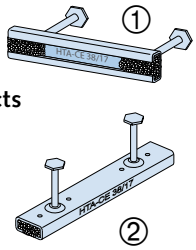
1.1 Delivery and identification

HALFEN can supply ready-to-install short channels and standard lengths.

Product identification – standard products

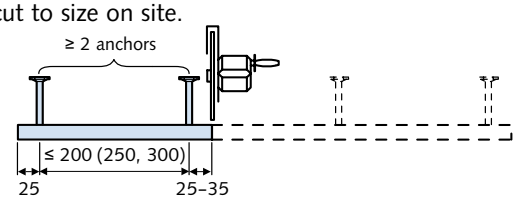
① embossment on the channel ridge, inside the channel.

② stamping on profile side or back of the channel (outside).



1.2 Installing to formwork

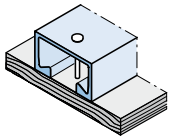
If required, HALFEN Cast-in channels can also be cut to size on site.

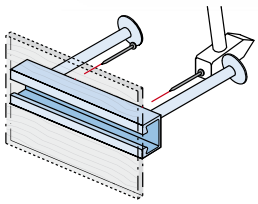


2.1 Fixing to the formwork

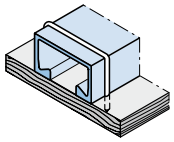
Timber formwork

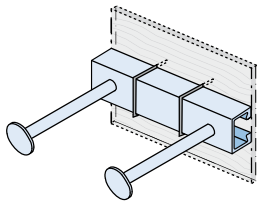
2.1.1 with nails





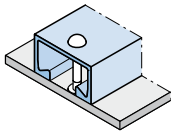
2.1.2 with staples

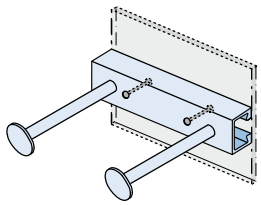




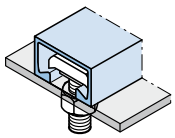
Steel formwork

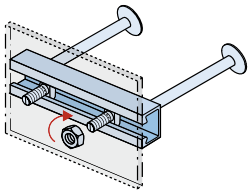
2.1.3 aluminium rivets



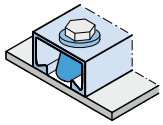


2.1.4 HALFEN Bolt and nut





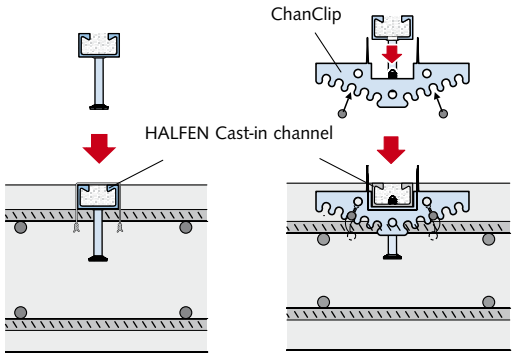
2.1.5 HALFEN HKK Fixing cone

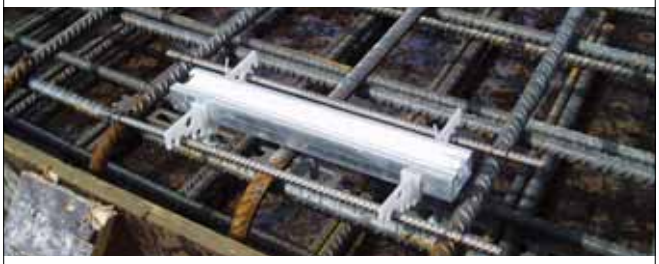


2.2 Top of slab installation

2.2.1 **directly to reinforcement:** with tying wire

2.2.2 **directly to reinforcement:** with HALFEN ChanClip





2.2.3 **Installation using auxiliary aid**

3.1 Removing the filler after concreting and striking the formwork

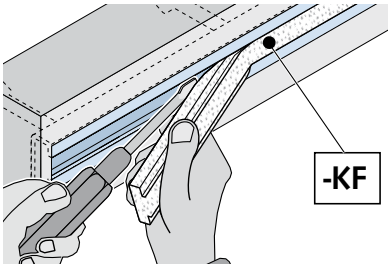
Characteristics of HALFEN KF-Polyethylene filler strips:

- closed-cell PE
- non-absorbent
- excellent weatherability
- resistant to ultaviolet light
- ability to compress and recover

KF - PE strip filler with reinforcement layer

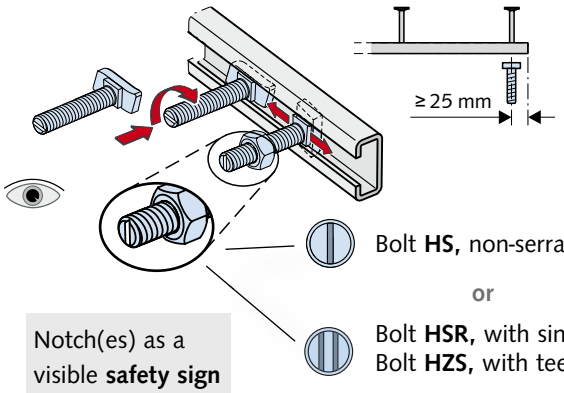
KF - PE strip filler

Notes:
- Filler can remain in the channel sections not used for fastening
- KF filler strips allow fast removal in one piece and easy collection for disposal
- Excessive strip filler has to be cut flush at the channel ends before installation



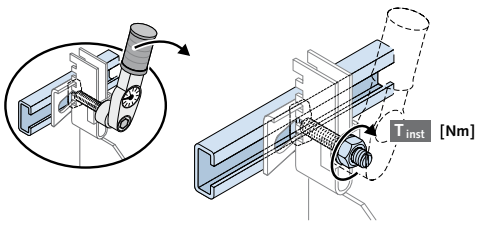
KF-PE strip filler:
Use a suitable tool to pull out one end of the strip, then pull out the entire filler by hand.

4.1 Installing HALFEN Bolts



Reliable assembly with HALFEN Cast-in channels
HALFEN Bolts can be inserted anywhere in the channel slot, are then turned 90° and locked in place by tightening the nut. Do not position bolts at channel ends past the last anchor (bolt position: ≥ 25 mm from the end of the channel). On channels with bolt anchors, the anchor locations are visible through the channel slot.

Check
Bolts: After installation check that the bolts are properly aligned; the notch(es) in the tip of the shank must be at right angles to the longitudinal axis of the channel.



Fixing
The bolt heads must sit flush on both flanks of the anchoring channel and be secured by tightening the nut with a torque wrench. The torque values in the tables on pages 31 and 32 must be observed.

Assembly instructions on the internet
Multi-language assembly instructions can be found at our website.
Or simply scan the code and select the required document.

HALFEN HZA DYNAGRIP

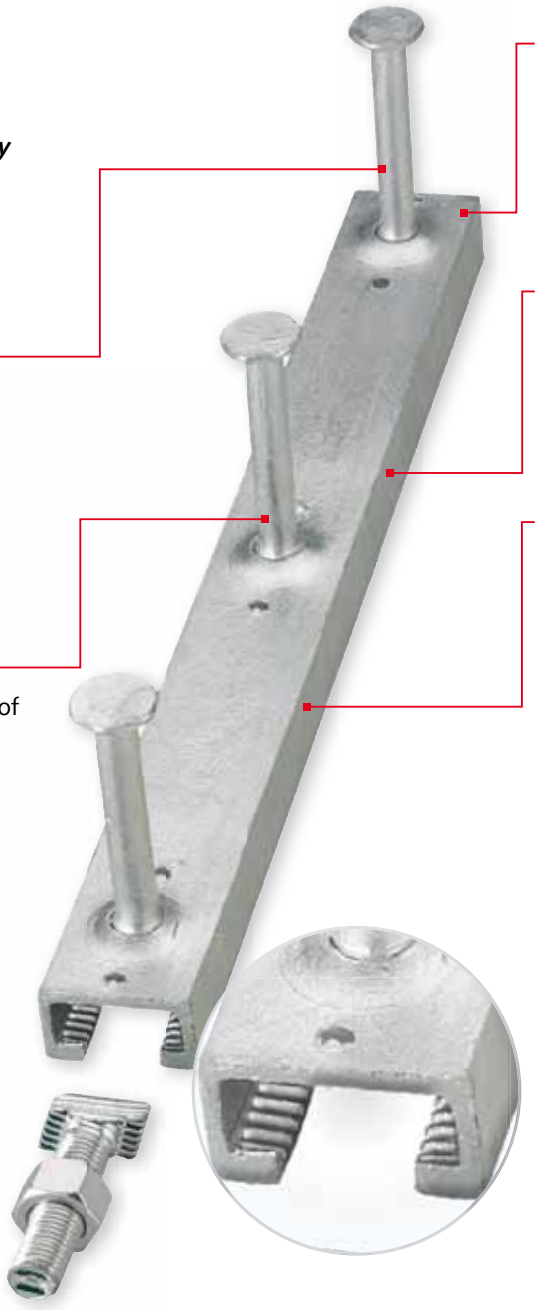
For fixings with highest requirements

DYNAGRIP
The most advanced channel generation

Cast into concrete of structural members and often not visible, HALFEN DYNAGRIP Channels are the hidden components that allow sophisticated structures to be successfully designed and built. DYNAGRIP Channels are typically the first choice whenever safety, sustainability, versatility and construction speed are the dominant project features.

Strong performance
High load capacity in all directions. Loads transferred deep into the concrete through the anchor head. Performance proven in cracked and non-cracked concrete.

Monitored manufacturing process
ensures the fully reliable connection of the anchors to the channel.



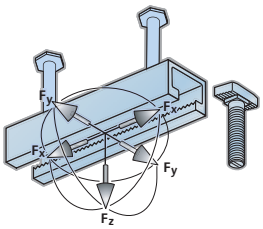
Tested for seismic loading
DYNAGRIP channels were successfully tested, according to the requirements in ACI 355.2-2007.

High dynamic load performance
Hot-rolled low stress profile provides high resistance to dynamic, impact and seismic loads.

Corrosion resistance
Channels and bolts can be supplied in various stainless steel grades, suitable for numerous applications.

Quality is assured
with building authority approvals and ISO 9001/2015 certification.

Environmentally friendly
with an EPD – Environmental product declaration for HTA-CE and HZA



Suitable for 3-D loading
Multi-direction loads are securely transferred into the concrete structure through the channel assembly. Components are securely connected using HALFEN T-bolts.

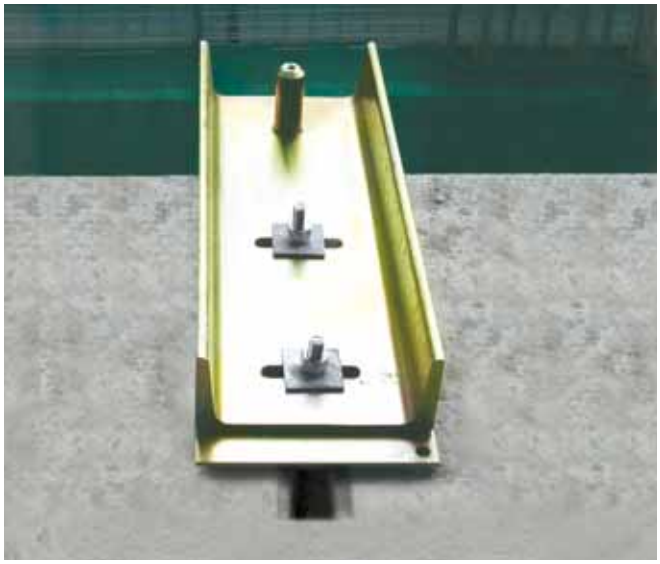
High longitudinal loads are transferred through the serration in the channel lips and the precisely matched HALFEN T-bolt.

- serrated profiles
- suitable for 3D-loading
- suitable for dynamic loads
- suitable for seismic loads

HALFEN HZA DYNAGRIP CAST-IN CHANNELS

Application Examples

CURTAIN WALL



Close to slab edge Curtain Wall bracket fixing using HZA

FAÇADES

Escape walkway with vertically installed HZA Channels

TUNNEL

Channel installation into tunnel segment formwork

TUNNEL

Finished precast segments with cast-in channels

ELEVATORS

Fixing for guide rails subject to dynamic loading

PRECAST CONSTRUCTION

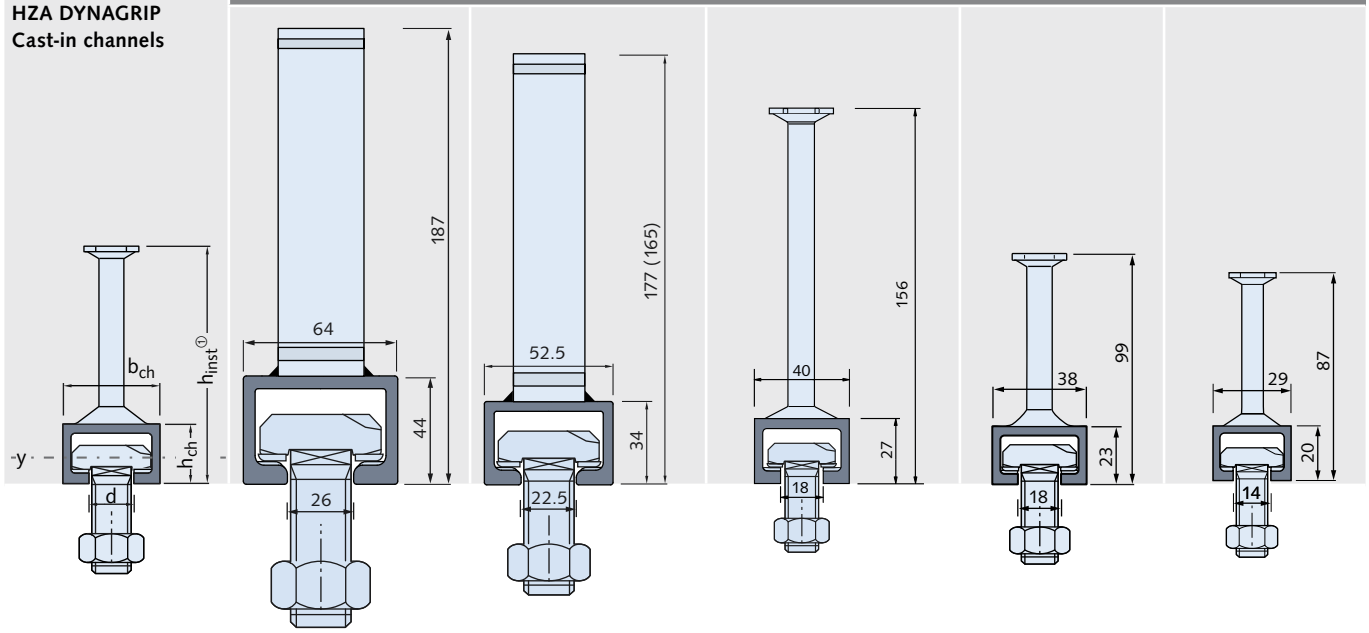
Vertically installed channels for pipe rack support

HALFEN HZA DYNAGRIP CAST-IN CHANNELS

Product Range

HALFEN HZA Cast-in channels DYNAGRIP

Profile	HZA 64/44 *DYNAGRIP*	HZA 53/34 *DYNAGRIP*	HZA 41/27 *DYNAGRIP*	HZA 38/23 *DYNAGRIP*	HZA 29/20 *DYNAGRIP*
Geometry HZA DYNAGRIP Cast-in channels	hot-rolled				



① Maximum installation height incl. production tolerance

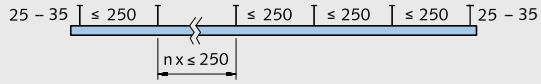
F_{Rd}	37.8 kN all load directions	30.8 kN all load directions	28.0 kN tension / transverse shear 16.8 kN longitudinal shear	16.8 kN all load directions	11.2 kN all load directions
Material	■ □	■ □	□	■ □	□
Bolt	HZS 64/44	HZS 53/34	HZS 38/23	HZS 38/23	HZS 29/20

□ **FV** = Steel hot-dip galvanized 1.0044 ■ **A4** = Stainless steel 1.4571/1.4404

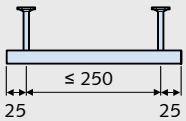
HALFEN HZA Cast-in channels DYNAGRIP – Lengths and Anchor spacings

HZA DYNAGRIP 38/23, 41/27, 53/34, 64/44

Fixed standard lengths (standard anchor spacings of s = 250):
Channel length = (no. of anchor spacings × 250) + 2×25 (2×35)



Short and made-to-order lengths (special anchor spacing s ≤ 250):
Example: channel length l = 300

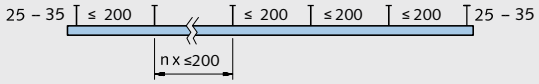


Short piece

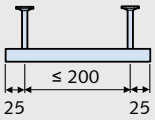
Dimensions in [mm]

HZA DYNAGRIP 29/20

Fixed standard lengths (standard anchor spacings of s = 200):
Channel length = (no. of anchor spacings × 200) + 2×25 (2×35)



Short and made-to-order lengths (special anchor spacing s ≤ 200):
Example: channel length l = 250



Short piece

Dimensions in [mm]

Design

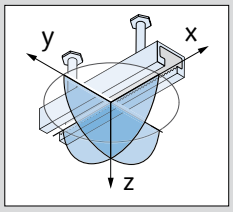
HZA DYNAGRIP Design resistances

Design resistance F_{Rd} in non-cracked / cracked concrete

Equal load bearing capacity in **all directions**

Concrete ≥ C20/25 ①

$$F_{Ed} = \sqrt{N_{Ed}^2 + V_{xEd}^2 + V_{yEd}^2} \leq F_{Rd}$$



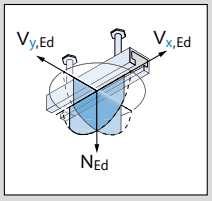
Profile HZA DYNAGRIP	Single loads F_{Rd} [kN]	Paired loads F_{Rd} [kN] ②		
	$b_i \geq 250$	$p_i \geq 50$	$p_i \geq 100$	$p_i \geq 150$
64/44	37.8	-	22.4	-
53/34	30.8 26.6 (for profiles in A4)	-	19.25	-
38/23	16.8	9.4	10.7	12.0
29/20	11.2	6.3	7.6	9.0

*s = Anchor spacing

Design resistance $F_{Rd\ and}$ $V_{x,Rd}$ for HZA 41/27 DYNAGRIP in non-cracked / cracked concrete

$$V_{x,Ed} \leq V_{x,Rd}$$
$$V_{y,Ed} \leq V_{y,Rd}$$
$$N_{Ed} \leq N_{Rd}$$
$$F_{Ed} = \sqrt{N_{Ed}^2 + V_{x,Ed}^2 + V_{y,Ed}^2} \leq F_{Rd}$$

Concrete ≥ C20/25 ①



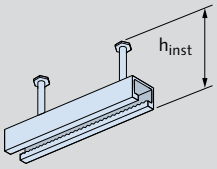
Profile HZA 41/27 DYNAGRIP	Single loads	Paired loads		
	$b_i \geq 250$	$p_i \geq 50$	$p_i \geq 100$	$p_i \geq 150$
$N_{Rd} = F_{Rd}$ [kN] ②	28.0	-	17.5	–
$V_{x,Rd}$ [kN] ②	16.8	9.4	10.7**	12.0**
$V_{y,Rd}$ [kN] ②	28.0	-	17.5	–

*s = Anchor spacing ** for actual test results see page 39

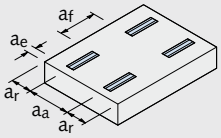
Minimum spacing a_r, a_e, a_a, a_f and h

Minimum (standard) spacing HALFEN HZA DYNAGRIP Cast-in channel [mm] *

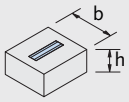
All dimensions in [mm]



Minimum channel spacing



Minimum component size

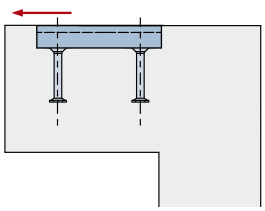


	a_r	a_a	a_e	a_f	b ③	h ④
HZA 64/44 DYNAGRIP	250	500	225	450	500	187 + c
HZA 53/34 DYNAGRIP	200	400	175	350	400	177 + c
HZA 41/27 DYNAGRIP	200	400	175	350	400	156 + c
HZA 38/23 DYNAGRIP	150	300	130	250	300	99 + c
HZA 29/20 DYNAGRIP	100	200	80	200	200	87 + c

*HALFEN Engineering can be contacted for verification of smaller spacing requirements

Channel spacing

The minimum spacing specified in the table applies to reinforced standard weight concrete of all strength classes ≥ C20/25. There are no requirements for reinforcement if spacing is increased by 30%.



Perpendicular channel arrangement

① The allowable loads for C20/25 may be reduced by the factor 0.7 when anchoring in concrete of strength class C12/15 and by a factor of 0.67 when anchored in lightweight dense concrete ≥ LC 25/28, expanded clay or slate or pumice-stone material.
② Intermediate values may be used linearly.
③ Minimum component width b = 2 x a_r applies for single channel configuration.
④ Determined by installation height h_{inst} plus concrete cover "c". h_{inst} = maximum installation height including tolerance.

HALFEN HTA-CE Cast-in channels

The Cast-in Channel with European Technical Approval

Apart from excellent adjustability, HALFEN Cast-in channels save considerable installation time. The result: faster construction and therefore reduced overall cost.

HALFEN HTA-CE Channels
cold-formed

HALFEN HTA-CE Channels
hot-rolled

suitable for dynamic loads

Safe and reliable

- no drilling – no damage to the reinforcement
- approved for fire-resistant structural elements (R120)
- suitable for use in concrete pressure and tensile stress zones (cracked / non-cracked concrete)
- high corrosion resistance steels available
- suitable for dynamic loads
- European Technical Approval
- precise calculation with HALFEN-Software

Quality is assured
with building authority approvals and ISO 9001/2015 certification.

Quick and economical

- adjustable anchoring
- bolts instead of welding
- maximum efficiency when installing matrices and rows
- cost effective installation using standard tools
- optimised pre-planning reduces construction time
- large range of types available for various requirements
- no noise, no vibration during installation, therefore no health hazards

CE European Technical Approval ETA-09/0339 432-CPD-8394-01

CE European Technical Assessment ETA-16/0453

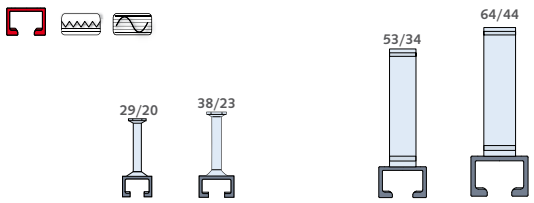
NEW: HTA-CE 50/30P and HTA-CE 40/22P. With more load capacity

HTA-CE with CE mark
HTA-CE Channels are designed according to CEN/TS 1992-4 (later EC2/EN1992), EOTA TR047 and bear the CE mark – a sign for tested quality and conformity to EC directives.

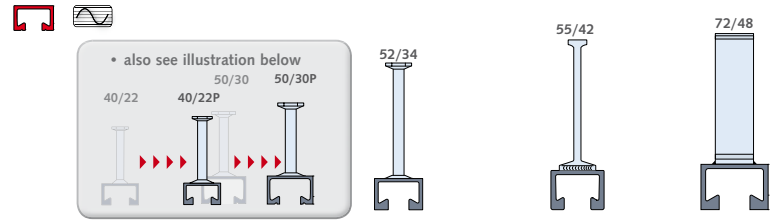
Channel range and steel load capacity/tension

HALFEN has enhanced its anchor channel range; two new channel profiles are now available: HTA-CE 40/22P and HTA-CE 50/30P.
The different profiles can now cover a significantly higher load range, providing up to 45 % more load capacity. Therefore allowing more economical solutions.

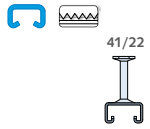
Load capacities for HALFEN Channels **hot-rolled, serrated**



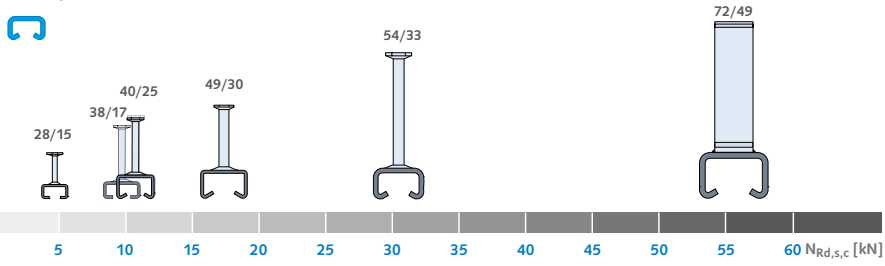
Load capacities for HALFEN Channels **hot-rolled**



Load capacities for HALFEN Channels **cold-rolled, serrated**



Load capacities for HALFEN Channels **cold-rolled**



HALFEN Anchor channels – with increased load capacity!

NEW!

New: HTA-CE 40/22P – Previously, for a load of N_{Ed} > 11.1 kN the next larger channel had to be selected; a HTA-CE 50/30 (with $N_{Rd,s,c}$ = 17.2 kN) instead of a HTA-CE 40/22.
Now in most cases the HTA-CE 40/22P (with $N_{Rd,s,c}$ = 16.1 kN) is sufficient.
This also allows a more economical screw to be used; a HS 40/22 instead of a HS 50/30.

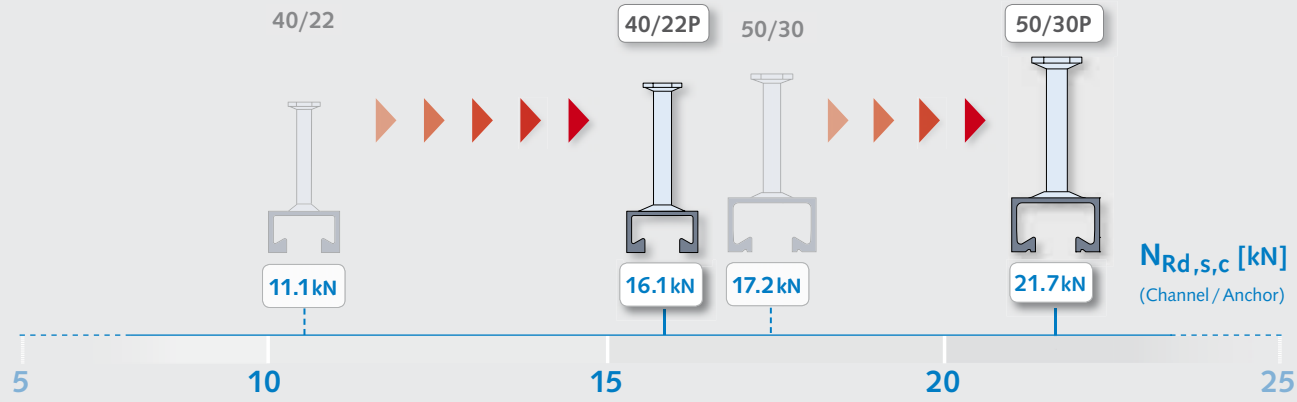
HTA-CE 50/30P – Previously, for a load of N_{Ed} > 17.2 kN the next larger channel had to be selected; a HTA-CE 52/34 (with $N_{Rd,s,c}$ = 30.6 kN) instead of a HTA-CE 50/30.
Now in most cases the HTA-CE 50/30P (with $N_{Rd,s,c}$ = 21.7 kN) is sufficient.

On-site safety: In many projects, different applications are therefore possible using a single channel profile. This reduces the risk of confusion when using different channels in one project. Furthermore, fewer bolt\screw types are required.

Minimal channel size for economical reinforcement layouts:
In respect to its load bearing capacity the new HTA-CE 40/22P can almost always be used instead of a HTA-CE 50/30.
With a height of only 23 mm, the new channel is almost always installed completely in the required concrete cover. This allows more efficient reinforcement planning (mesh and supplementary reinforcement).

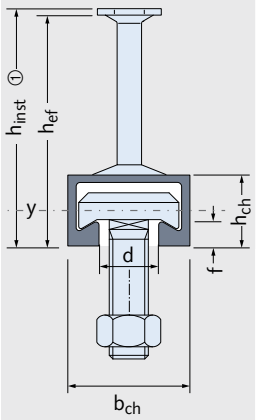
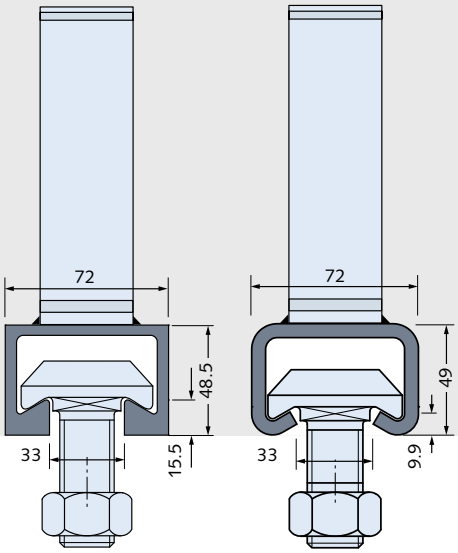
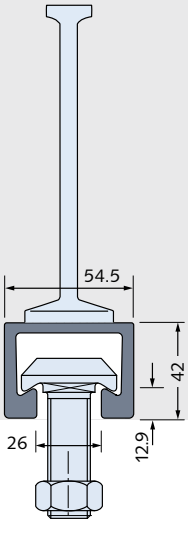
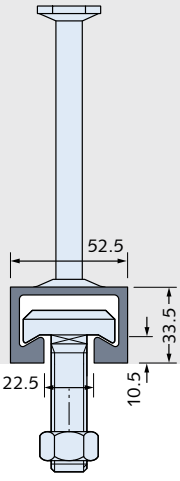
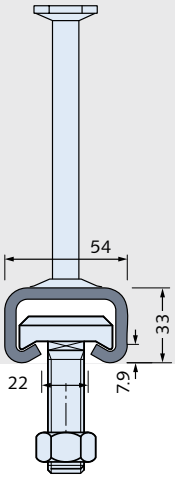
European certification:
The new HTA-CE 40/22P and HTA-CE 50/30P types are included in ETA-16/0453 and are therefore certified for use, without restrictions, in 30 European countries.

HTA-CE with improved load capacity (Illustrated: Steel load capacity/tension)



HALFEN CAST-IN CHANNELS HTA-CE

Product Range: Overview of Channels + Bolts

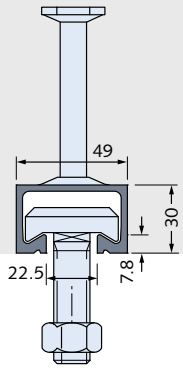
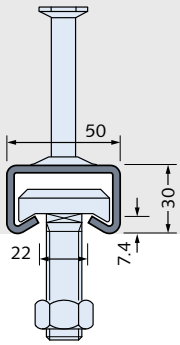
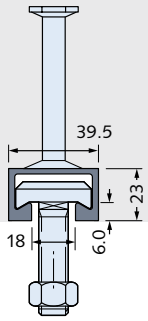
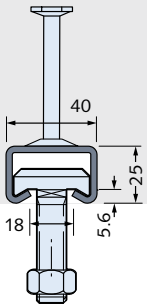
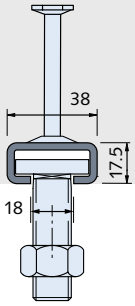
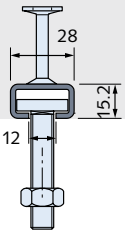
Indentification values HTA-CE							
Profile		HTA-CE 72/48	HTA-CE 72/49	HTA-CE 55/42	HTA-CE 52/34	HTA-CE 54/33	
Type		hot-rolled	cold-rolled	hot-rolled	hot-rolled	cold-rolled	
Geometry HALFEN Channels HTA-CE **Note:** observe the installation height h_{inst}								
Material	Steel	■		■	■	■	
	A4	■	■		■	■	
	HCR						
Bolts		HS 72/48	HS 72/48	HS 50/30	HS 50/30	HS 50/30	
Threads		M20 - M 30	M20 - M30	M10 - M20	M10 - M20	M10 - M20	
s_{slb} [mm]		129	129	109	88	88	
Profile load capacity							
$N_{Rd,s,l}$ [kN]		55.6	55.6	44.4	36.1	30.6	
$V_{Rd,s,l}$ [kN]		72.2		57.8	39.7		
$M_{Rd,s,flex}$ [Nm]	Steel	7472	-	5606	2933	2595	
	NR	7630	7493	-	2996	2595	
Geometry							
h_{inst} [mm] ① ②		(191)	(193)	182 (185)	162 (164)	161 (164)	
b_{ch} [mm]		72	72	54.5	52.5	54	
h_{ch} [mm]		48.5	49	42	33.5	33	
I_y [mm⁴]	Steel	349721	293579	187464	93262	72079	
	NR						
h_{ef} [mm]		179	179	175	155	155	
c_{min} [mm]		150	150	100	100	100	

* Concrete load capacity has to be verified for each individual case (taking the geometric boundary conditions into account).

c_{min} = minimal spacing channel/concrete edge
NR = Stainless steel
s_{slb} = axial spacing for bolts for $N_{Rd,s,l}$
$N_{Rd,s,l}$ = channel lip load capacity (tension)
$V_{Rd,s,l}$ = channel lip load capacity (shear)
① Nominal size and tolerance
② ( ) value in brackets is for weld-on I-anchors
Materials: See page 12

HALFEN CAST-IN CHANNELS HTA-CE

Product Range: Overview of Channels + Bolts

	HTA-CE 50/30P NEW!	HTA-CE 49/30	HTA-CE 40/22P NEW!	HTA-CE 40/25	HTA-CE 38/17	HTA-CE 28/15
	hot-rolled	cold-rolled	hot-rolled	cold-rolled	cold-rolled	cold-rolled
						
	☐	☐	☐	☐	☐	☐
	☐	☐	☐	☐	☐	☐
		☒			☒	☒
	HS 50/30	HS 50/30	HS 40/22	HS 40/22	HS 38/17	HS 28/15
	M10 - M20	M10 - M20	M10 - M16	M10 - M16	M10 - M16	M6 - M12
	98	81	79	65	52	42
	21.7 22.4	17.2	19.4	11.1	10.0	5.0
	2437	1455	1208	956	504	276
	2743	1485	1358	931	516	282
	112 (161)	103 (101)	97 (154)	89 (89)	81 (82)	50 (79)
	49	50	39.5	40	38	28.0
	30	30	23	25	17.5	15.25
	52575	41827	19859 19859	20570 19097	8547	4060
	106	94	91	79	76	45
	75	75	50	50	50	40

Design

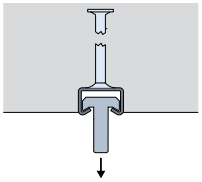
Verification method according to CEN/TS 1992-4 / EOTA TR 047 / EN 1992-4

VERIFICATIONS

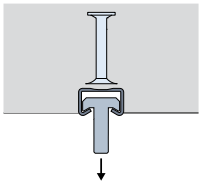
Tension

Steel

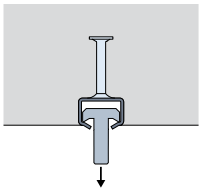
- Steel failure of the anchor



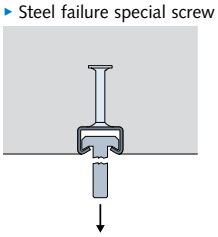
- Failure of channel-anchor connection



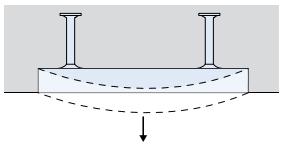
- Local flexure of the channel lip



- Steel failure special screw

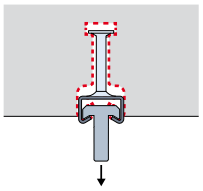


- Failure due to flexure of the channel

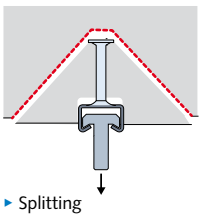


Concrete

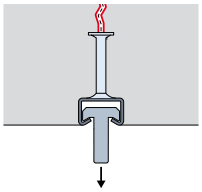
- Pull-out



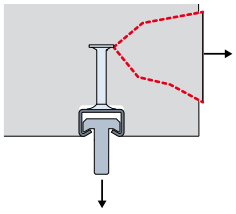
- Concrete cone failure



- Splitting



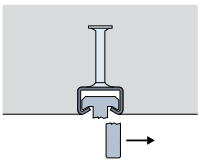
- Blow-out



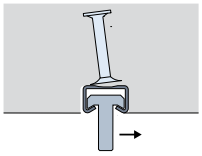
Shear

Steel

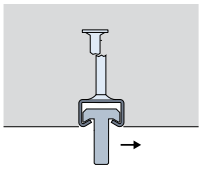
- Steel failure of the screw



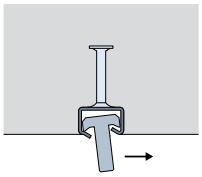
- Failure of channel-anchor connection



- Steel failure of the anchor

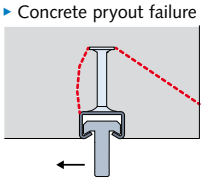


- Local flexure of the channel lip

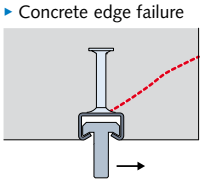


Concrete

- Concrete pryout failure



- Concrete edge failure



Additional verifications / tension

- Steel failure in supplementary reinforcement
- Failure of the supplementary reinforcement in the failure cone

Additional verifications / shear

- Special screw for shear loads with lever arm
- Steel failure in supplementary reinforcement
- Bond failure of reinforcement

Decisive verifications for tension and shear

Superposition

HALFEN Software

The HALFEN Cast-in channel design software allows the flexible design for HALFEN HTA-CE and HZA Cast-in channels. The software, a powerful and convenient design tool, can be downloaded from the HALFEN website.

HTA-CE Channel design

Optionally the cast-in channel verification can be done following the provisions of

- CEN/TS 1992-4
- EOTA TR 047
- AC 232.

HZA DYNAGRIP design

The design follows the provisions of the National Technical Approval Z-21.4-1691. The design includes verifications of loads acting in the longitudinal direction of the HZA DYNAGRIP Channels.

Input

The geometry and loads are entered interactively. Entries are displayed promptly in a 3D graphic. Entries can also be changed directly in the graphic. Click on the load, the measurement or the component line you want to change to make the required modification. Various options to take existing or additional reinforcement into account are provided.

Results

After calculation, the software output provides either the results for a preselected profile, or – in the case of automatic selection – a list of all suitable profiles. The important results such as degree of utilisation or the decisive mode of failure are displayed in clear overview so that they are easy to understand.

Having the knowledge of the decisive failure mode allows the engineer to modify relevant boundary conditions in order to optimize the cast-in channel design.

Screenshot 1: The HALFEN Software start screen

Screenshot 2: Input GUI (Graphic User Interface), HALFEN Software

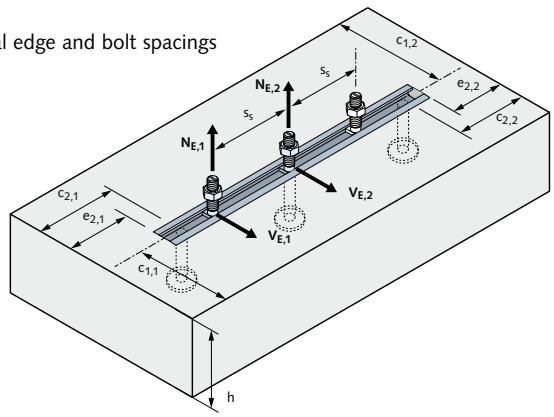
Minimum edge distances and minimum bolt spacing

Anchors must be installed at a minimum distance from the component edges. The distance depends on the selected channel profile and the corresponding HALFEN T-bolt.

According to the ETA, the spacing between bolts s_s must not be less than $5 \times d_s$. Reduction is required if $s_s < s_{slb}$*.

*s_{slb} = centre distance of the bolts for N_{Rd} (→ see also page 22)

Figure: Minimal edge and bolt spacings



Edge and bolt spacing [mm]

HTA-CE profiles	28/15				38/17			40/25 40/22 P			49/30				50/30 P				54/33 52/34				55/42				72/49 72/48			
M	6	8	10	12	10	12	16	10	12	16	10	12	16	20	10	12	16	20	10	12	16	20	10	12	16	20	20	24	27	30
$s_{s,min}$	30	40	50	60	50	60	80	50	60	80	50	60	80	100	50	60	80	100	50	60	80	100	100	60	80	100	100	120	135	150
c_{min}	40				50			50			75				75				100				100				150			
e_{min}	15				25			25			50				40				65				65				115			

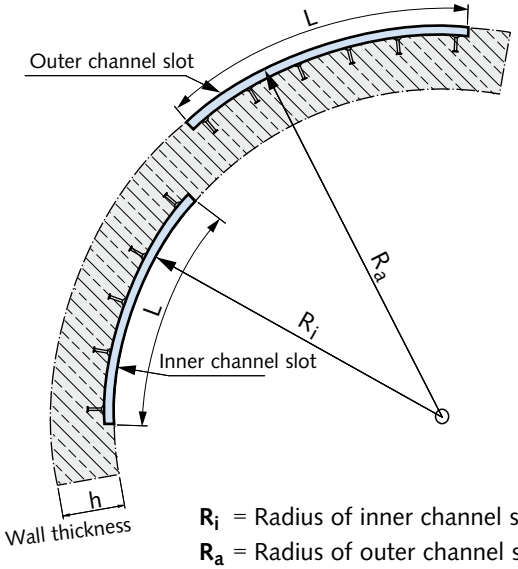
HALFEN Channels – Curved Solutions

Due to equal load bearing characteristics in all directions HZA DYNAGRIP Channels are particularly suitable for applications in tunnels.

Areas of application
- tunnel construction
- reinforced concrete pipes for utility shafts
- curved walls
- sewage plants

Ordering example:
HALFEN Cast-in channel, curved
HZA-CS 38/23 - A4,
Ri = 4000 mm, L = 1050 mm

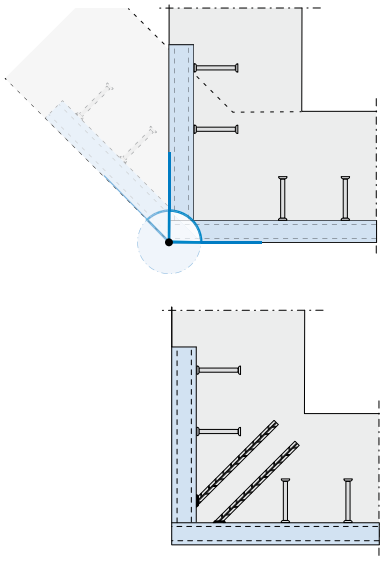
Curved HALFEN Cast-in channels in tunnel segments



R_i = Radius of inner channel slot
R_a = Radius of outer channel slot
L = Length of channel after bending (max. 5400 mm)

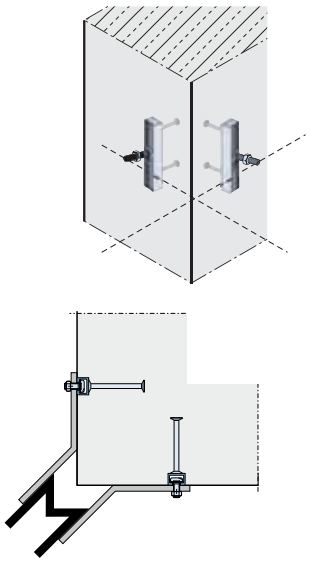
HALFEN Corner channel

Conventional solutions (at times on-site solutions)



- Channels must be welded together by manufacturer to avoid liability disputes
- Reinforcement congestion to be considered for installation feasibility
- Different corner angles require different special constructions

Use of serrated HZA DYNAGRIP Channels



- Standard short channels can be used - no welding required
- Due to offset-arrangement channels can be installed closely to edge without collision of bolt anchors.
- Increased safety

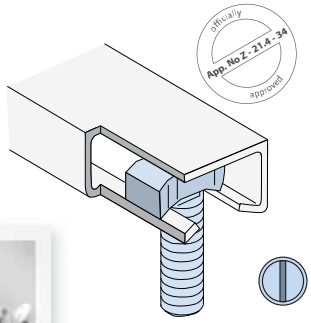
HALFEN Bolts

The Advantages at a Glance

HALFEN HS Bolts with S-shaped head for an even more reliable fit: The special shape of the head ensures enhanced protection against bolt slippage in the channel.

HALFEN HS Bolts
for all type of HTA profiles
- load bearing in 2 directions
- identified on the shank tip with 1 notch

Type HS

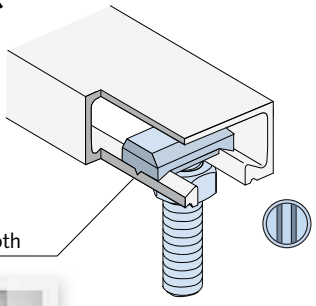


CE ETA - 09 / 0339 432-CPD-8394-01

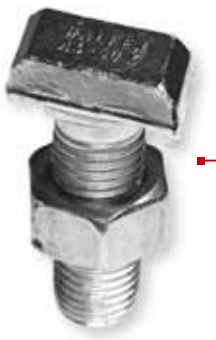
CE ETA - 16 / 0453

HALFEN HSR Bolt with single tooth
- positive interlock between tooth and channel profile lip
- allows the application of considerably high longitudinal loads – in combination with HDG hot-rolled channels
- allows high torque moments
- identified on the shank tip with 2 notches

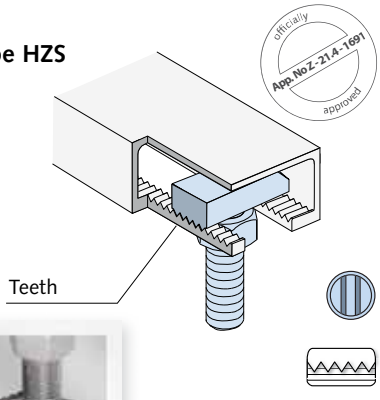
Type HSR



HALFEN HZS serrated Bolts
- completely serrated T-bolt head ensures optimal positive locking in the longitudinal direction, all risk of slippage is eliminated.
- suitable for dynamic and seismic applications
- identified on the shank tip with 2 notches



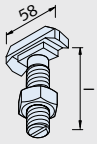
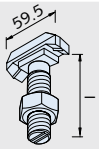
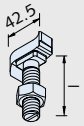
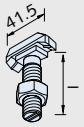
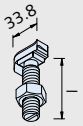
Type HZS



HALFEN BOLTS

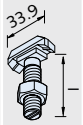
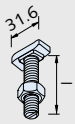
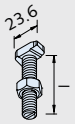
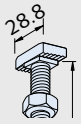
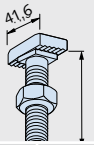
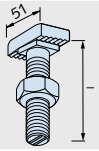
Product Range

HALFEN Bolts HS / HSR / HZS

Suitable for profile	HTA-CE 72/48, 72/49				HTA-CE 72/48	HTA-CE 55/42, 52/34, 54/33, 50/30P, 49/30				HTA-CE 55/42, 52/34, 50/30P		HTA-CE 40/22P, 40/25		
Bolt type	**HS 72/48**				**HSR 72/48**	**HS 50/30**				**HSR 50/30**		**HS 40/22**		
Bolt size														
l [mm] / ⌀	**M 20**	**M 24**	**M 27**	**M 30**	**M20**	**M10**	**M 12**	**M 16**	**M 20**	**M16**	**M20**	**M 10**	**M 12**	**M 16**
15														
20												GVs4.6	GVs4.6	
25														
30						FV4.6 GVs4.6	A4-70 GVs4.6	A4-50 GVs4.6				A4-70 GVs4.6	A4-50 FV4.6 GVs4.6 GVs8.8	A4-50 GVs4.6
35									GVs4.6					
40						GVs4.6	A4-70 FV4.6 GVs4.6	A4-50 FV4.6 GVs4.6 GVs8.8		FV8.8		A4-70 GVs4.6	A4-50 A4-70 GVs4.6 GVs8.8	GVs4.6
45							GVs8.8		A4-50 GVs4.6 GVs8.8		GVs8.8		GVs8.8	
50	FV4.6	A4-50 FV4.6				GVs4.6	A4-70 GVs4.6	HCR-50* A4-50 FV4.6 GVs4.6				A4-70 GVs4.6	A4-50 FV4.6 GVs4.6	A4-70 A4-50 A4-50L FV4.6 GVs4.6
55									A4-50 FV4.6 GVs4.6					
60	FV8.8						FV4.6 FV8.8* GVs4.6 GVs8.8	A4-50 FV8.8 GVs4.6 GVs8.8	GVs8.8	GVs8.8	GVs8.8	GVs4.6	FV4.6 FV8.8* GVs4.6 GVs8.8	FV4.6 FV8.8 GVs4.6 GVs8.8
65									GVs4.6					
70														
72														
75	FV4.6 GVs8.8	FV4.6 FV8.8	FV4.6	FV4.6	FV8.8				A4-50 GVs4.6		GVs8.8			
80							FV8.8* GVs4.6 GVs8.8	HCR-50* A4-50 A4-50L FV8.8* GVs4.6 GVs8.8	FV4.6* GVs8.8			GVs4.6	A4-50 A4-50L FV4.6 GVs4.6 GVs8.8	A4-50 A4-50L GVs4.6 GVs8.8
87							A4-70T	A4-70T						
100	FV4.6 GVs8.8	A4-50 FV4.6 GVs8.8	FV8.8	FV4.6			A4-50 GVs4.6	A4-50T FV4.6 GVs4.6 GVs8.8	A4-50 FV4.6 GVs4.6 GVs8.8			GVs4.6	GVs4.6 GVs8.8	A4-50 FV4.6 GVs4.6
125							GVs4.6	GVs4.6	A4-50 GVs4.6				GVs4.6	GVs4.6
150	FV4.6	FV4.6		FV4.6			GVs4.6	A4-50 FV4.6 GVs4.6	A4-50 GVs4.6 GVs8.8				GVs4.6	GVs4.6
200	FV4.6	FV4.6		FV4.6			GVs4.6	GVs4.6	GVs4.6				GVs4.6	GVs4.6
250														GVs4.6
300								GVs4.6	GVs4.6					GVs4.6

L = left-hand thread **T** = partial thread GVs = special thick layer passivation **FV** = hot-dip galvanized **A2, A4, HCR** = stainless steel grades * on request

Product Range

Profile	HTA-CE 40/22P	HTA-CE 38/17, HZA 38/23			HTA 28/15				HZA 29/20	HZA 38/23 HZA 41/27		HZA 53/34		HZA 64/44	
Bolt type	HSR 40/22	HS 38/17			HS 28/15				HZS 29/20	HZS 38/23		HZS 53/34		HZS 64/44	
Bolt size															
l / ø	M16	M 10	M 12	M 16	M 6	M 8	M10	M12	M12	M12	M16	M16	M20	M20	M24
15					GVs4.6	GVs4.6	GVs4.6								
20		GVs4.6	GVs4.6		GVs4.6	GVs4.6 GVs8.8	GVs4.6								
25				A4-50	GVs4.6	GVs4.6	A4-70 GVs4.6								
30		A4-70 FV4.6 GVs4.6	A4-70 FV4.6 GVs4.6	A4-50 GVs4.6	GVs4.6	A4-70 GVs4.6	HCR-50* A4-70 FV4.6 GVs4.6	GVs4.6	GVs8.8	GVs8.8					
35								GVs4.6							
40	GVs8.8	GVs4.6	A4-70 GVs4.6	A4-50 FV4.6 GVs4.6	GVs4.6	GVs4.6	A4-70 FV8.8 GVs4.6		GVs8.8	GVs8.8	GVs8.8				
45															
50		FV4.6 GVs4.6	A4-70 A4-50L FV4.6 GVs4.6	A4-50 A4-50L FV4.6 GVs4.6		GVs4.6	HCR-50* A4-70 A4-50L FV4.6 GVs4.6	GVs4.6	FV8.8* GVs8.8	FV8.8* GVs8.8	GVs8.8				
55															
60	FV8.8* GVs8.8	GVs4.6	HCR-50* A4-70 GVs4.6 GVs8.8	A4-50 FV8.8 GVs4.6		GVs4.6	GVs4.6		GVs8.8	GVs8.8	A4-70 FV8.8 GVs8.8	A4-70 FV8.8* GVs8.8			
65													A4-70 FV8.8* GVs8.8		
70			FV8.8												
72			A4-70T												
75															
80		GVs4.6	A4-70 A4-50L GVs4.6	A4-50 FV4.6 GVs4.6		GVs4.6	A4-70 GVs4.6	GVs4.6	GVs8.8	GVs8.8	A4-70 FV8.8* GVs8.8	FV8.8*	FV8.8*	A4-70* FV8.8* GVs8.8*	A4-70* GVs8.8*
87															
100		GVs4.6	A4-50 GVs4.6	FV4.6 GVs4.6		GVs4.6	GVs4.6			GVs8.8	GVs8.8	A4-70 FV8.8* GVs8.8	A4-70 GVs8.8		FV8.8*
125			GVs4.6	GVs4.6			GVs4.6							A4-70* GVs8.8*	
150		GVs4.6	GVs4.6	GVs4.6			GVs4.6				GVs8.8				A4-70* GVs8.8*
200			GVs4.6	GVs4.6			GVs4.6								
250															
300															

HALFEN T-bolts listed above are standard stock items; alternative T-bolt configurations available on request (*).

Bolt design values HS

The design resistance of HALFEN Bolts with different thread diameters materials and strength classes can be found in the table on the right.

$N_{Rd,s,s}$ is the resistance against tension loads, $V_{Rd,s,s}$ against shear loads and $M^0_{Rd,s,s}$ is the flexural resistance when subjected to transverse load induced in a cantilever.
The bending moment verification for HS-bolts is integrated in the new HALFEN Cast-in channel design software and no longer requires manual verification.

Design values in longitudinal direction
In general the following three combinations can be used in supporting-structures subjected to loads in channel longitudinal direction:

- hot-rolled, non-serrated, hot-dip galvanized channels with HALFEN T-bolts HSR
- serrated HALFEN Channels HZA with serrated HALFEN T-bolts HZS
- non-serrated channels with HALFEN T-bolts HS based on friction only (resistance values on the right)

Design resistances according to ETA 09/0339

Material			M 6	M 8	M 10	M 12	M 16	M 20	M 24	M 27	M 30
4.6	$N_{Rd,s,s}$	[kN]	4.0	7.3	11.6	16.9	31.4	49.0	70.6	91.8	112.2
	$V_{Rd,s,s}$	[kN]	2.9	5.3	8.3	12.1	22.6	35.2	50.7	66.0	80.6
	$M^0_{Rd,s,s}$	[Nm]	3.8	9.0	17.9	31.4	79.8	155.4	268.9	398.7	538.7
8.8	$N_{Rd,s,s}$	[kN]	10.7	19.5	30.9	44.9	83.7	130.7	188.3	244.8	299.2
	$V_{Rd,s,s}$	[kN]	6.4	11.7	18.6	27.0	50.2	78.4	113.0	146.9	179.5
	$M^0_{Rd,s,s}$	[Nm]	9.8	24.0	47.8	83.8	213.1	415.4	718.4	1065.2	1439.4
Stainless steel -50	$N_{Rd,s,s}$	[kN]	3.5	6.4	10.1	14.8	27.4	42.8	61.7	80.2	98.1
	$V_{Rd,s,s}$	[kN]	2.5	4.6	7.3	10.6	19.8	30.9	44.5	57.9	70.7
	$M^0_{Rd,s,s}$	[Nm]	3.2	7.9	15.7	27.5	70.0	136.3	235.8	349.7	472.5
Stainless steel -70	$N_{Rd,s,s}$	[kN]	7.5	13.7	21.7	31.6	58.8	91.7	132.1	171.8	210.0
	$V_{Rd,s,s}$	[kN]	5.4	9.9	15.6	22.7	42.2	66.0	95.1	123.6	151.0
	$M^0_{Rd,s,s}$	[Nm]	6.9	16.8	33.5	58.8	149.4	291.3	503.7	746.9	1009.2

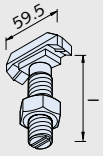
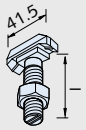
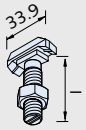
Design value F_{Rd} [kN] in channel longitudinal direction (per bolt)

	for steel profiles		for profiles in Stainless steel	
	Bolt type HS with strength class			
Thread Ø	4.6	8.8 ①	A4-50	A4-70
M 6	0.14	0.56		
M 8	0.28	0.98	0.28	
M 10	0.42	1.54	0.42	
M 12	0.70	2.24	0.70	
M 16	1.26	4.20	1.26	
M 20	1.96	6.58	1.96	
M 24	2.80	9.52	2.80	
M 27	3.64	12.46		
M 30	4.48	15.26		

① Values only appliable with torque moments T_{inst} steel-steel (see table on the right, on page 31)

Bolt design values HSR

Available HSR

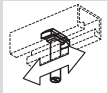
Suitable for profile	72/48	52/34, 50/30P		40/22P
Bolt	HSR 72/48	HSR 50/30		HSR 40/22
Bolt dimensions				
l [mm]	M20	M16	M20	M16
40		FV8.8		GVs8.8
45			GVs8.8	
60		GVs8.8	GVs8.8	GVs8.8, FV8.8*
75	FV8.8		GVs8.8	

GVs = Zinc galvanized with special coating
FV = Hot-dip galvanized
* on request

Torque values

HSR 8.8	Torque T_{inst} [Nm]
M16	200
M20	400

Load capacity

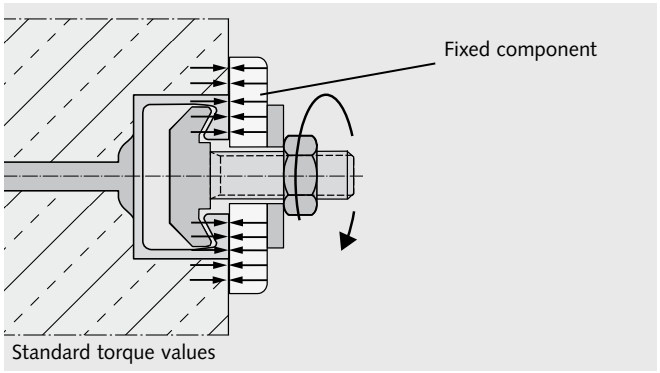


HSR 8.8

	F_{Rd} in channel longitudinal direction according to expert report F_{Rd} [kN]
40/22 - M16	7.0
50/30 - M16	7.0
50/30 - M20	10.5
72/48 - M20	10.5

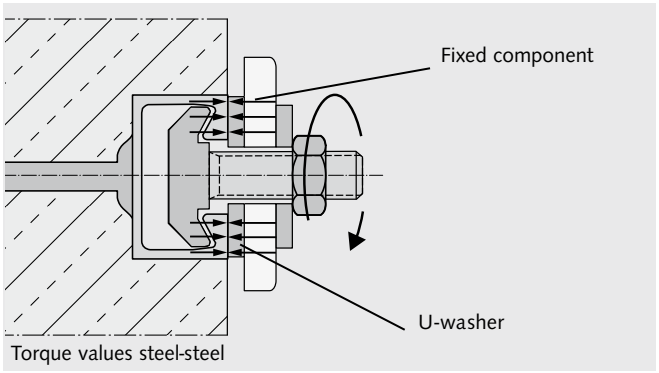
Torque values HS

Standard
Components are braced against the concrete and anchor channel.
Torque is applied as in the following table and must not be exceeded.



Standard torque values

Steel-Steel
Components are braced against the anchor channels using suitable washers.
Torque is applied as in the following table and must not be exceeded.



Torque values steel-steel

Standard: Recommended torque values T_{inst}

HTA-CE Profile	HALFEN Bolt HS...**M** [mm]	Torque value T_{inst} [Nm] Steel 4.6; 8.8 Stainless steel Strength class 50 Strength class 70
28/15	6	–
	8	8
	10	13
	12	15
38/17	10	15
	12	25
	16	40
40/22P 40/25	10	15
	12	25
	16	45
49/30 50/30P	10	15
	12	25
	16	60
	20	75
52/34 54/33	10	15
	12	25
	16	60
	20	120
55/42	10	15
	12	25
	16	60
	20	120
72/48 72/49	20	120
	24	200
	27	300
	30	380

Steel-Steel: Recommended torque values T_{inst}

HTA-CE Profile	HALFEN Bolt HS...**M** [mm]	Torque value T_{inst} [Nm] Steel 4.6	Steel 8.8	Stainless steel Strength class 50	Stainless steel Strength class 70
28/15	6	3	–	3	–
	8	8	20	8	15
	10	15	40	15	30
	12	25	70	25	50
38/17	10	15	40	15	30
	12	25	70	25	50
	16	65	180	60	130
40/22P 40/25	10	15	40	15	30
	12	25	70	25	50
	16	65	180	60	130
49/30 50/30P	10	15	40	15	30
	12	25	70	25	50
	16	65	180	60	130
	20	130	360	120	250
52/34 54/33	10	15	40	15	30
	12	25	70	25	50
	16	65	180	60	130
	20	130	360	120	250
55/42	10	15	40	15	30
	12	25	70	25	50
	16	65	180	60	130
	20	130	360	120	250
72/48 72/49	20	130	360	120	250
	24	230	620	200	440
	27	340	900	300	650
	30	460	1200	400	850

Torque values apply only to bolts in delivery condition (unlubricated).

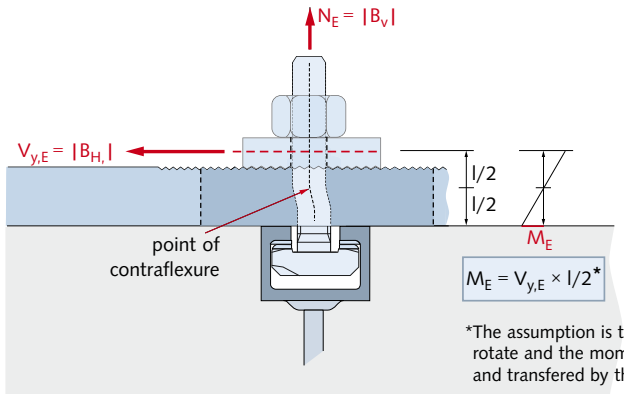
Verification for bolt bending

As part of the HZS Bolt verification, it must be verified that the design rating of the absorbable bending moment is not exceeded.

The method of verification for HZS T-bolts under bending stress as well as the respective design ratings can be found in the table and the illustration below.

Bolt type HZS - Design ratings F_{Rd} and M_{Rd} ①

Bolt type	Grade 8.8			Stainless steel A4-70		
HZS	F_{Rd} [kN]	Bending moment per bolt ② M_{Rd} [Nm]	Torque T_{inst} [Nm]	F_{Rd} [kN]	Bending moment per bolt ② M_{Rd} [Nm]	Torque T_{inst} [Nm]
29/20 - M12	27.2	61.2	80	–	–	–
38/23 - M12	27.2	61.2	80	–	–	–
38/23 - M16	50.5	155.4	120	33.0	116.6	120
53/34 - M16	50.5	155.4	200	33.0	116.6	200
53/34 - M20	79.0	303.0	350	51.5	227.2	350
64/44 - M20	79.0	303.0	350	51.5	227.2	350
64/44 - M24	113.7	524.0	450	54.3	183.4	450



*The assumption is that the attachement cannot rotate and the moment M_{Ed} can be taken up and transfered by the attachment.

Required verification

$$N_{Ed} \leq F_{Rd} \times (1 - M_{Ed} / M_{Rd})$$

F_{Rd} = Design resistance value for HZS bolts

M_{Rd} = Design resistance value of the possible bending moment

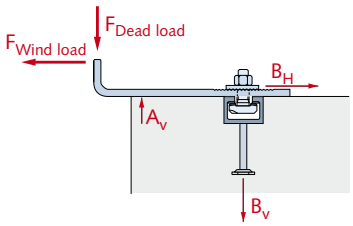
N_{Ed} = Design value of the present tensile load component

M_{Ed} = Design value of the present bending moment

① Observe the load-bearing capacity of the profile! In case of a difference in the load-bearing capacity of the bolt and the HALFEN Cast-in channel, use the smaller value.

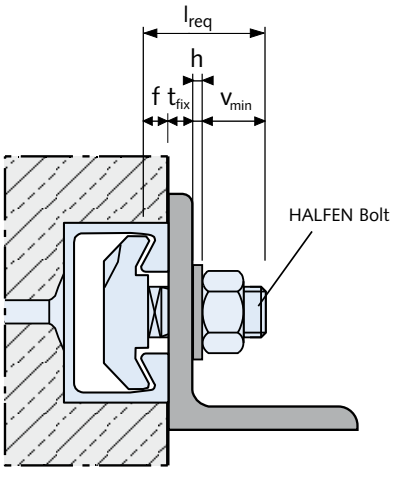
② Bending moment at the upper surface of the profile.

Note: Combine stress values if bending occurs with additional centric or diagonal tensile stress.
→ see required verification above



Calculating the bolt length l_{req} for HALFEN Bolts

$$l_{req} = t_{fix} + f + h + v_{min}$$



Dimensions v_{min}

Bolt diameter	v_{min} [mm]
M6	11.0
M8	12.5
M10	14.5
M12	17.0
M16	20.5
M20	26.0
M24	29.0
M27	31.5
M30	33.5

Lip dimensions f

Channel profile	f [mm]
28/15	2.25
38/17	3.0
40/22P	6.0
40/25	5.6 / 5.4 ①
49/30	7.39
50/30P	7.85
52/34	10.5
54/33	7.9
55/42	12.9
72/48	15.5
72/49	9.9

① value **f** for stainless steel

l_{req} = required bolt length
t_{fix} = thickness of clamped component
f = profile lip height
h = washer thickness
v_{min} = nut height EN ISO 4032 + overhang approximately 5 mm (for M20: 7 mm)

HCW Curtain Wall

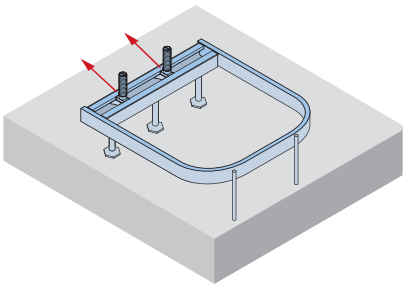
The advantages at a glance

Today´s modern buildings require façades of the highest quality that can be erected quickly and safely. This is the reason the Curtain wall system is chosen more and more frequently by architects and investors.

Fast and cost-effective

- 3-dimensional adjustable connection when used with anchor channels
- uses bolts instead of welds
- fast assembly reduces installation time
- high on-site efficiency

HCW 52/34
Used for anchorage of high wind loads. Channel repeatedly and independently tested in thin concrete slab conditions.



HZA DYNAGRIP channel
For anchorage of element façades together with HALFEN Curtain wall brackets. Superior performance due to 3D-load bearing capability and suitability in earthquake regions.

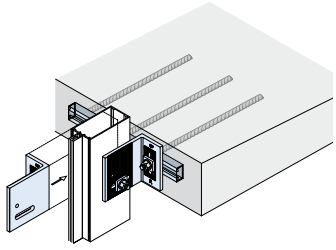
Environmental friendly

- no noise or dust during installation
- no electrical power required for installation

Safe

- based on state-of-the art design concepts and approvals by recognized authorities
- manufactured under stringent QA/QC (Quality Assurance and Quality Control) in our German factories
- reliable and easy-to-check installation quality

HTA-R / HZA-R Channel
For anchorage of mullion-transom façades together with HALFEN Curtain wall brackets.
Perfectly suitable for face-of-slab installations.



HALFEN HCW CURTAIN WALL

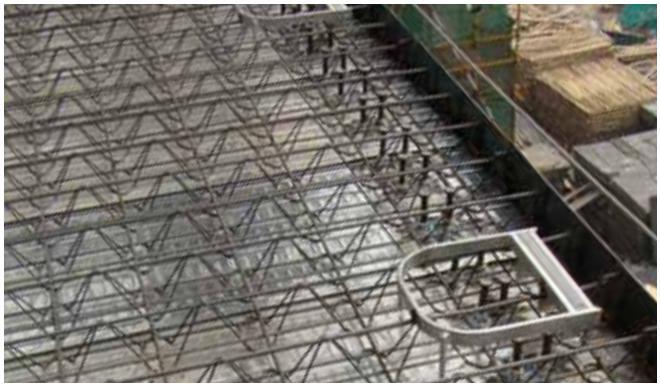
Application Examples

Sunscreen fixing with HZA Channels (detail view → picture on the right)

Custom-made brackets attached to vertically installed DYNAGRIP Channel pair

Mullion fixing using HCW-ED Brackets

Top of slab fixing – colour marked for quality check



Special channel HCW 52/34: anchorage of high wind loads in thin slabs

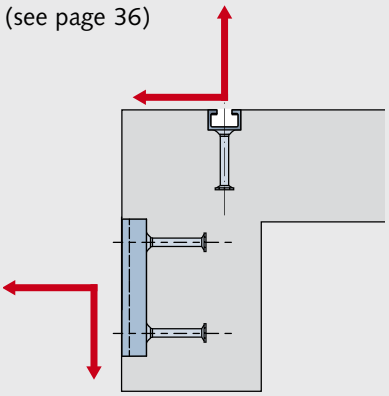
Fixing of curtain wall system using HCW-B2 Brackets connected to HTA-CE Anchor channels

Typical curtain wall fixing with HTA-CE Anchor channel

Façade bracket fixing close to concrete edges of slab

Normal slab conditions or edge beam situations

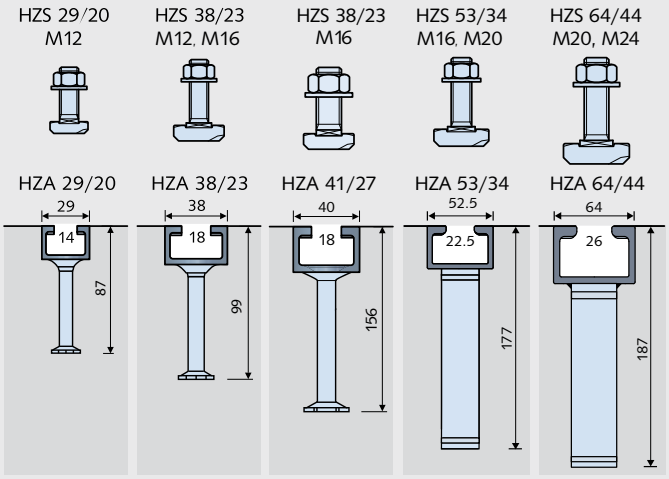
Normal load condition
(see page 36)



Front of beam

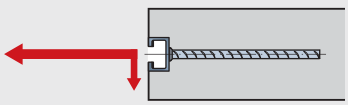
- Standard channels with bolt anchors (I-anchors)

Serrated channels HZA DYNAGRIP + HZS Bolts



Thin slab conditions

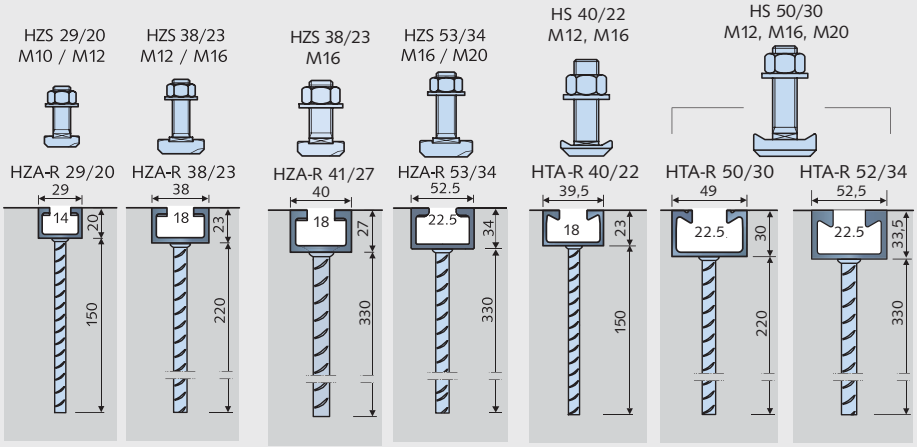
High tension, small shear
(see page 40)



- Standard channels with rebar anchors

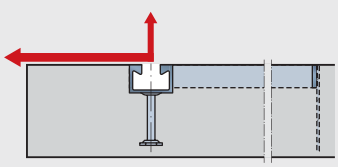
Serrated channels HZA-R + HZS Bolts

Non-serrated channels HTA-R + HS Bolts

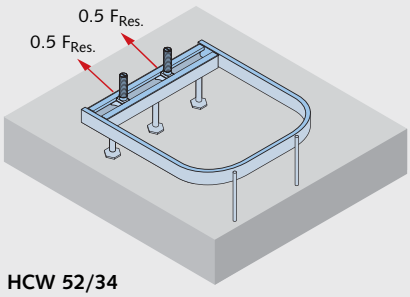


High shear loading in thin slab application

High shear, small tension
with small edge distances
(see page 42)



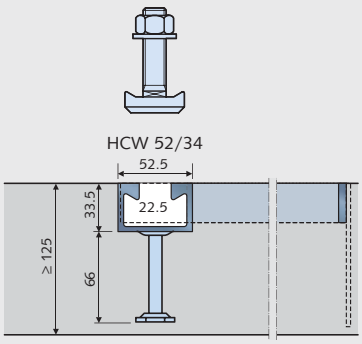
- High shear load channel



HCW 52/34

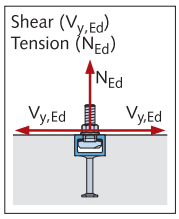
Non-serrated channel HCW + HS Bolts

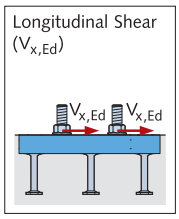
HS 50/30, M16, M20
grade 8.8

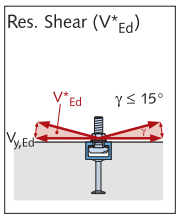


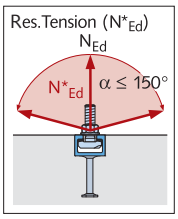
Design: Normal Slab or Edge Beam Applications

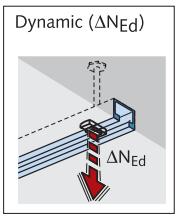
Structural analysis

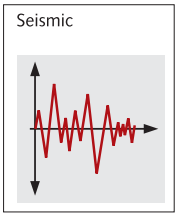








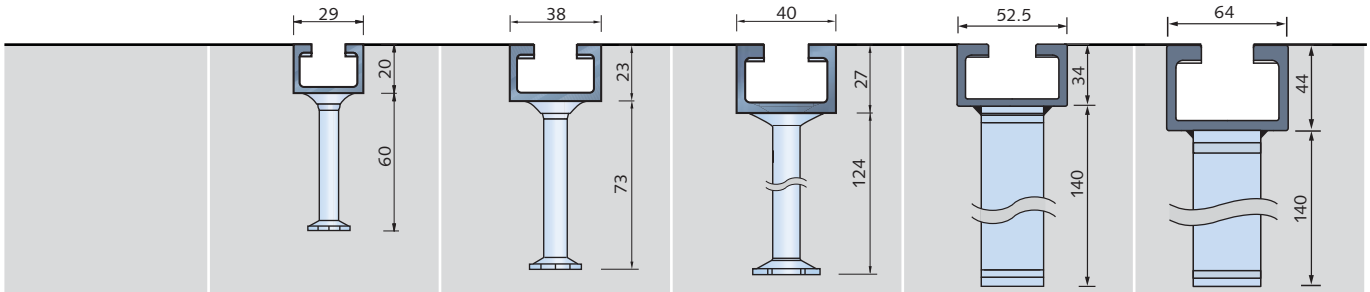


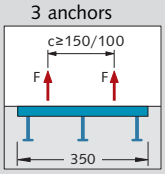
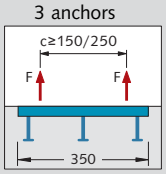
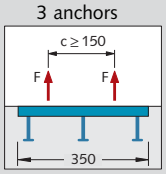
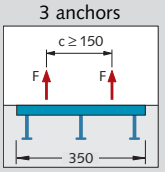
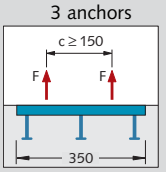


Required verifications	F_{Rd} Material resistance		F_{Ed} Factored design load		
Shear Material Resistance	$V_{y,Rd}$	≥	$V_{y,Ed}$		
Tension Material Resistance	N_{Rd}	≥	N_{Ed}		
Longitudinal Shear Material Resistance	$V_{x,Rd}$	≥	$V_{x,Ed}$		
Resultant Shear Material Resistance	V^*_{Rd}	≥	res. V_{Ed}		$= \sqrt{(V_{x,Ed})^2 + (V_{y,Ed})^2}$
	V^*_{Rd}	≥	V^*_{Ed}	($\gamma < 15°$)	$= \sqrt{(N_{Ed})^2 + (\text{res.}V_{Ed})^2}$
Resultant Tension Material Resistance	N^*_{Rd}	≥	N^*_{Ed}	($\gamma \geq 15°$ $\alpha \leq 150°$)	$= \sqrt{(N_{Ed})^2 + (\text{res.}V_{Ed})^2}$
Dynamic Material Resistance	ΔN_{Rd}	≥	ΔN_{Ed}	(calculated with γ_F=1.0)	

$$\gamma = \arctan\left(\frac{N_{Ed}}{\text{res. } V_{Ed}}\right)$$

HALFEN HZA Cast-in channels DYNAGRIP– material design resistance values



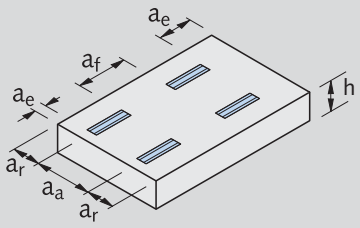
HALFEN Channel type	**HZA 29/20** 350 mm 3 anchors	**HZA 38/23** 350 mm 3 anchors	**HZA 41/27** 350 mm 3 anchors	**HZA 53/34** 350 mm 3 anchors	**HZA 64/44** 350 mm 3 anchors
Concrete compression strength ≥ C20/25 $f_{ck,cyl.}$ = 20 N/mm² $f_{ck,cube}$ = 25 N/mm²					
N_{Rd} [kN]	2 × 11.2/ 8.4 ③	2 × 14.0 / 16.8 ④	2 × 28.0	2 × 30.8 / 26.6 ⑥	2 × 37.8
$V_{y,Rd}$ [kN]	2 × 8.4	2 × 14.0	2 × 21.6	2 × 23.8	2 × 18.9
$V_{x,Rd}$ [kN]	2 × 9.0	2 × 12.0	2 × 12.0	2 × 19.25	2 × 27.0
N^*_{Rd} [kN]	2 × 11.2 / 8.4 ③	2 × 14.0 / 16.8 ④	2 × 28.0	2 × 30.8 / 26.6 ⑥	2 × 37.8
V^*_{Rd} [kN]	2 × 8.4	2 × 14.0	2 × 21.6	2 × 23.8	2 × 18.9
$\Delta F = \Delta N_{Rd}$ [kN] ⑤	2 × 2.0	2 × 3.0	2 × 3.0	2 × 12.0	2 × 15.0
Material: hot-dip galvanized	channel: 1.0044 anchor: 1.0205	channel: 1.0044 anchor: 1.0205	channel: 1.0044 anchor: 1.5523 or 1.5535	channel: 1.0044 anchor: 1.0038	channel: W1.0044 anchor: W1.0038

Notes: ③ 2 × 8.4 at c ≥ 100, 2 × 11.2 at c ≥ 150
④ 2 × 14 at c ≥ 150, 2 × 16.8 at c ≥ 250
⑤ for $\Delta N_{E,d}$ calculated with γ_F = 1.0
⑥ value applies for stainless steel A4 only

Design: Normal Slab or Edge Beam Applications

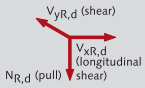
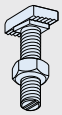
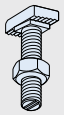
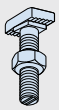
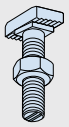
Minimum spacings and edge distances [mm], for all concrete grades ≥ C20/25 ①

HALFEN Channel type	a_r	a_a	a_e	a_f	h ②
HZA 29/20	100	200	80	200	87 + nom.c
HZA 38/23	150	300	130	250	99 + nom.c
HZA 41/27	200	400	175	350	156 + nom.c
HZA 53/34	200	400	175	350	177 + nom.c
HZA 64/44	250	500	225	450	187 + nom.c



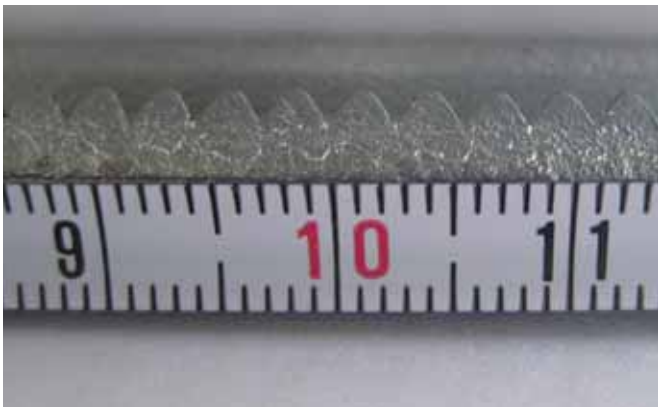
Notes: ① The minimum dimensions given in the table apply to reinforced concrete. For unreinforced concrete increase dimensions by 30%.
② Derived from channel plus anchor plus the required concrete cover.
HALFEN´s Engineering Support must be contacted for verification purpose!

HALFEN T-head bolts HZS – material design resistance values ③

HALFEN Channel type	**HZA 29/20** 350 mm 3 anchors	**HZA 38/23** 350 mm 3 anchors	**HZA 41/27** 350 mm 3 anchors	**HZA 53/34** 350 mm 3 anchors	**HZA 64/44** 350 mm 3 anchors
HALFEN T-bolt type	HZS 29/20 M12 x 60 GVs 8.8	HZS 38/23 M12 x 60 GVs 8.8 (M16 x 60 GVs 8.8)	HZS 38/23 M16 x 60 GVs 8.8	HZS 53/34 M20 x 65 GVs 8.8 (M16 x 60 GVs 8.8)	HZS 64/44 M20 x 80 GVs 8.8 (M24 x 80 GVs 8.8)
					
$N_{Rd} = V_{y,Rd} = F_{S,Rd}$ [kN]	27.2	27.2 (50.5)	50.5	79.0 (50.5)	79.0 (113.7)
$V_{x,Rd}$ [kN]	11.2	16.8	16.8	30.8 (30.8)	37.8 (37.8)
$\Delta F \equiv \Delta N_{Rd}$ [kN] ④	2.0	2.0 (3.0)	3.0	6.0 (6.0)	15.0 (15.0)
Required torque [Nm]	80	80 (120)	120	350 (200)	350 (450)

③ Note: do not exceed channel load capacity!
GVs 8.8 = Special thick layer passiviation, grade 8.8.
The verification for bolt bending must not be omitted (→ see page 32).

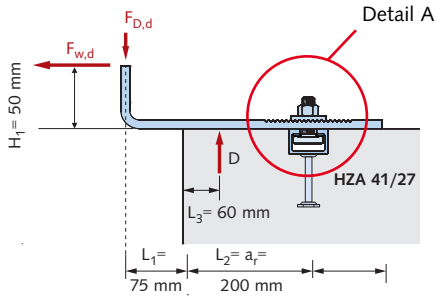
④ for $\Delta N_{E,d}$ calculated with $\gamma_F = 1.0$

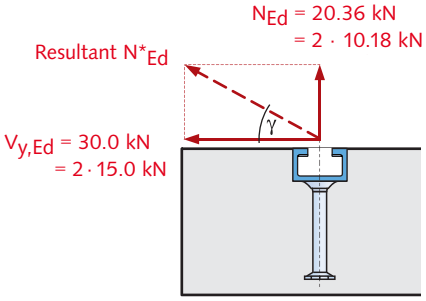


Close-up of serration pitch of HZA 38/23

Hong Kong Science Park II – application HZA 41/27

Design-Example 1: Top of slab situation (parallel layout)

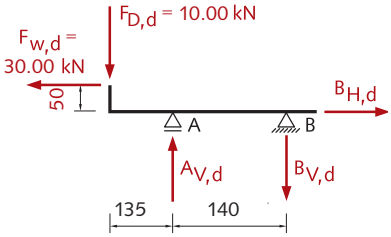




Recommendation from HALFEN
for assumption of location of resultant concrete compression force D:

$$0.1 \cdot L_2 \le L_3 \le 1/3 \cdot L_2$$

L_3 has to be specified by the responsible façade engineer!
For this example → L_3 = **0.3 · L_2 = 60 mm**



Given:
Factored design loads:
– design dead load $F_{D,d}$ = 10.00 kN
– design wind load $F_{w,d}$ = 30.00 kN

Design forces, acting on the channel:

N_{Ed} ≙ $B_{V,d}$ = $(F_{D,d} \cdot 135 + F_{w,d} \cdot 50) / 140$
= $(10.00 \cdot 135 + 30.0 \cdot 50) / 140$ = **20.36 kN**

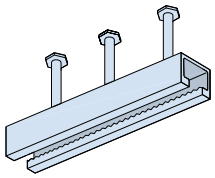
$V_{y,Ed}$ ≙ $B_{H,d}$ = $F_{w,d}$ = **30.0 kN**

$\gamma = \arctan(N_{Ed} / V_{y,Ed}) = \arctan(20.36 / 30.00)$ = **34.16°** > 15°

N^*_{Ed} ($\gamma \ge 15°$) = $\sqrt{N_{Ed}^2 + V_{y,Ed}^2}$

N^*_{Ed} = $\sqrt{(20.36)^2 + (30.00)^2}$ = 36.26 kN
≙ **2 · 18.13 kN**

Selected channel → **HZA 41/27 - 350 - 3 anchors with 2 bolts at 150 mm centres** (→ p. 36)


HZA 41/27

required a_r = 200 mm (→ page 37) ✓ OK

⇒ $V_{y,Rd}$	=	2 · 21.6 kN	>	$V_{y,Ed}$	=	2 · 15.00 kN	✓ OK
N_{Rd}	=	2 · 28.0 kN	>	N_{Ed}	=	2 · 10.18 kN	✓ OK
N^*_{Rd}	=	2 · 28.0 kN	>	N^*_{Ed}	=	2 · 18.13 kN	✓ OK

Selected bolts → **2 pieces HZS 38/23 M16 x 60 GVs 8.8** (→ p. 29)

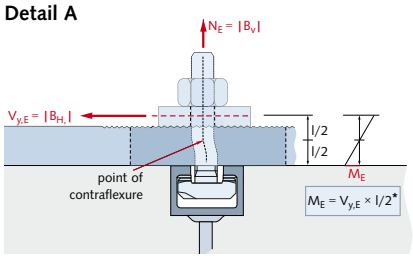

HZS 38/23

required torque: T_{inst} = 120 Nm (→ page 32)

⇒ $V_{y,Rd}$	=	50.5 kN	>	$V_{y,Ed}$	=	15.00 kN	✓ OK
N_{Rd}	=	50.5 kN	>	N_{Ed}	=	10.18 kN	✓ OK
$F_{S,Rd}$	=	50.5 kN	>	$F_{S,Ed}$	=	18.13 kN	✓ OK

Verification bolt bending

Detail A



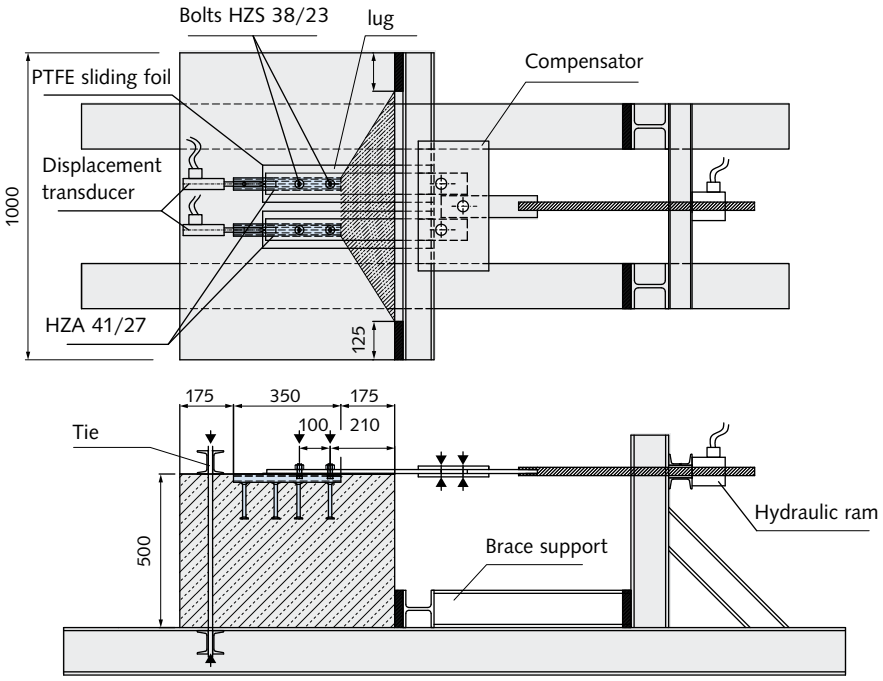
l = 12 + 8/2 = 16 mm = 0.016 m

to check $N_{Ed} \le F_{Rd} \times (1 - M_{Ed} / M_{Rd})$

with M_{Ed} = $V_{y,Ed} \cdot l/2$ = 15.000 [N] · 0.016 [m]/2 = 120 [Nm]
F_{Rd} = 50.5 kN
M_{Rd} = 155.4 Nm } see page 32
10.18 < 50.5 · (1 – 120 / 155.4)
10.18 < 11.5 ✓ OK

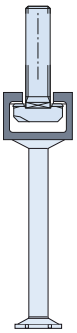
Test with HALFEN DYNAGRIP HZA 41/27: Longitudinal shear load applied via 2 pairs of T-bolts

Test arrangement



Schematic sketch: transverse load in longitudinal direction of channel

Test setup with HZA 41/27



HZA 41/27 - 350
+ **Bolts HZS 38/23 – M16 8.8**
- torque 200 Nm
- concrete grade 30 ± 3 MPa

Test results

Longitudinal shear load HZA 41/27 with four HALFEN Bolts HZS 38/23 (M16)		
Test number	**max. applied load [kN]**	**Failure type**
1	144.88	Failure of serration
2	165.16	Failure of serration
3	149.89	Failure of serration
4	154.34	Failure of serration
5	169.99	Failure of serration
Mean value x_m	156.85	–
Standard deviation σ_x	10.48	–

5% quantile with a confidence level of 90%

$x_p = x_m - k \cdot \sigma_x$

Value of quantile factor k
depends on the number of tests:
for 5 tests ⇒ k = 3.4

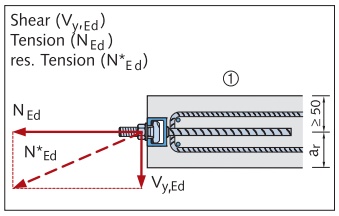
$x_{5\%} = 156.85 - 3.4 \cdot 10.48 = 121.2$ kN

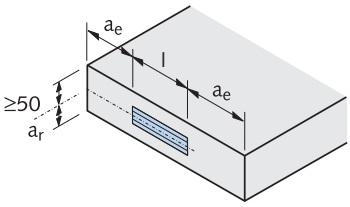
Conclusions

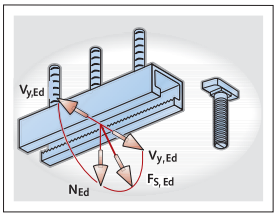
- Based on the test results above, using the 5%-Quantile value and applying a material safety factor of $\gamma_M = 1.8$, the design steel resistance of the channel serration per bolt has been determined as follows:
- 121.2 kN / 4 bolts = 30.3 kN
  30.3 kN / 1.8 = **16.83 kN** > 10.7 kN = $V_{x,Rd}$
  (→ see page 19).
- The test results achieved confirm that the steel load bearing capacity of the channel serration is not reduced by the smaller bolt spacing of 10 cm.

Depending on the application in each specific project; this lay-out of the T-bolt pairs could be an economic design for high shear load applications in the longitudinal channel direction.

Structural analysis





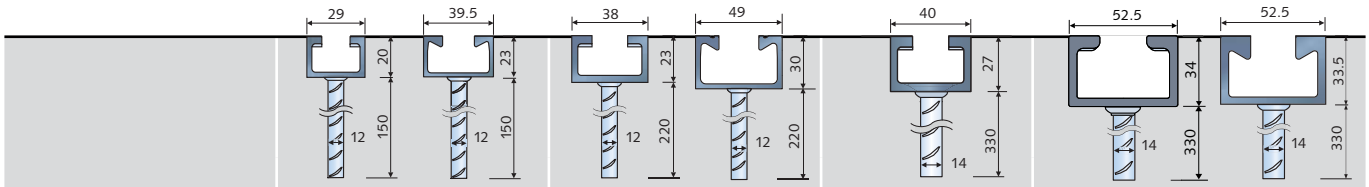


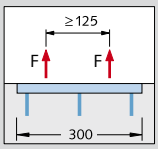
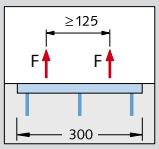
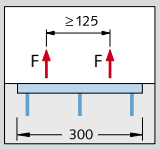
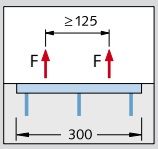
Note: ① The minimum dimensions given in the table apply to reinforced concrete.

Verifications:

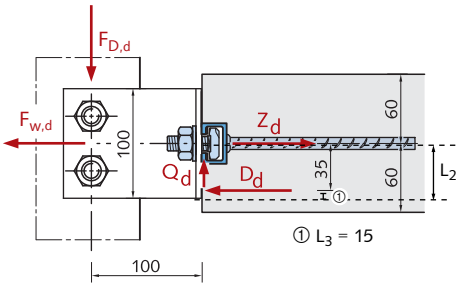
	F_{Rd} Material resistance		F_{Ed} Factored design load	
Shear Material Resistance	$V_{y,Rd}$	≥	$V_{y,Ed}$	
Tension Material Resistance	N_{Rd}	≥	N_{Ed}	
Resulting Tension Material Resistance	N^*_{Rd}	≥	N^*_{Ed}	$= \sqrt{N_{Ed}^2 + V_{y,Ed}^2}$

HALFEN Cast-in channels HTA-R and HZA-R - material design resistance values

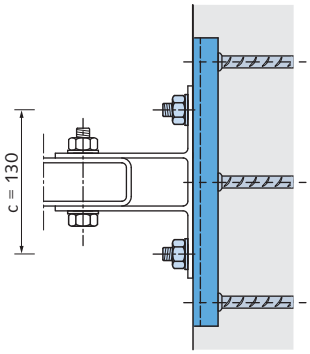


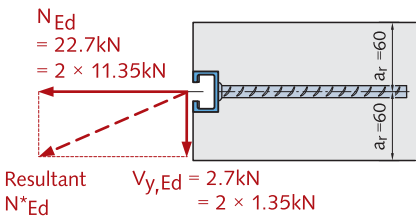
HALFEN Channel type		HZA-R 29/20	HTA-R 40/22	HZA-R 38/23	HTA-R 50/30	HZA-R 41/27	HZA-R 53/34	HTA-R 52/34
		300 mm 3 anchors	300 mm 3 anchors	300 mm 3 anchors	300 mm 3 anchors	300 mm 3 anchors	300 mm 3 anchors	300 mm 3 anchors
Concrete compression strength ≥ C20/25 $f_{ck,cyl.}$ = 20 N/mm² $f_{ck,cube}$ = 25 N/mm²								
$N_{Rd} = N^*_{Rd}$ [kN]		2 · 9.1		2 · 14.0		2 · 22.3	2 · 24.5	
a_r [mm]	a_e [mm]	V_{yRd} [kN]						
≥ 50	≥ 40	2 · 2.4						
≥ 60	≥ 45	2 · 3.7						
≥ 70	≥ 50	2 · 4.9						
≥ 75	≥ 50	2 · 5.6						
Material: hot-dip galvanized	channel	1.0044	1.0038	1.0044	1.0038	1.0044	1.0044	1.0038
	anchor	B500B reinforcing steel						

Design-Example 2: Front of slab situation



All dimensions in [mm]





Recommendation by HALFEN
assuming the location of resultant concrete compression force D:

$$\mathbf{0.1 \cdot L_2 \le L_3 \le 1/3 \cdot L_2}$$

L_3 has to be specified by the responsible façade engineer!

Given:
Factored design loads:
⇒
- design dead load $F_{D,d}$ = 2.7 kN
- design wind load $F_{w,d}$ = 15.0 kN

Design forces, acting on the channel:

$\mathbf{N_{Ed}}$ ≙ Z_d = $F_{w,d} + F_{D,d} \cdot (100 / 35)$
= $15.0 + 2.7 \cdot (100 / 35)$ = **22.7 kN**

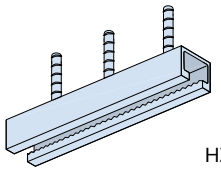
$\mathbf{V_{y,Ed}}$ ≙ Q_d = $F_{D,d}$ = **2.7 kN**

$N^*_{Ed} = \sqrt{N_{Ed}^2 + V_{y,Ed}^2}$

$= \sqrt{(22.7)^2 + (2.7)^2} = 22.86$ kN

≙ **2 · 11.43 kN**

Selected channel ⇒ **HZA-R 38/23 - 300 - 3 anchors with 2 bolts at 130 mm centre** (see page 40)



HZA-R 38/23

actual a_r = 60 mm (→ page 40)

⇒ $V_{y,Rd}$	=	2 · 3.7	>	$V_{y,Ed}$	=	2 · 1.35	✓ OK
N_{Rd}	=	2 · 14.0	>	N_{Ed}	=	2 · 11.35	✓ OK
N^*_{Rd}	=	2 · 14.0	>	N^*_{Ed}	=	2 · 11.43	✓ OK

Selected bolts ⇒ **2 pieces HZS 38/23 M12 x 60 GVs 8.8** (see page 37)

HZS 38/23

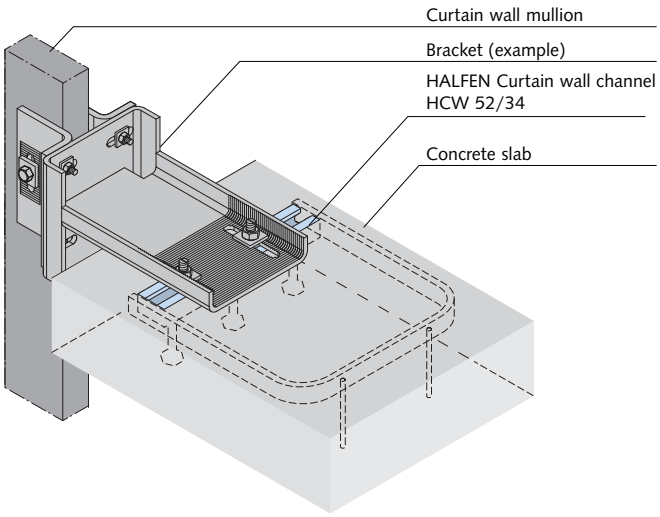
actual c = 130			>	required c ≥ 125 (→ p. 40)			✓ OK
⇒ $V_{y,Rd}$	=	27.2	>	$V_{y,Ed}$	=	1.35	✓ OK
N_{Rd}	=	27.2	>	N_{Ed}	=	11.35	✓ OK
$F_{S,Rd}$	=	27.2	>	$F_{S,Ed}$	=	11.35	✓ OK

Required torque T_{inst} = 80 Nm (→ see page 32)

HALFEN HCW CURTAIN WALL

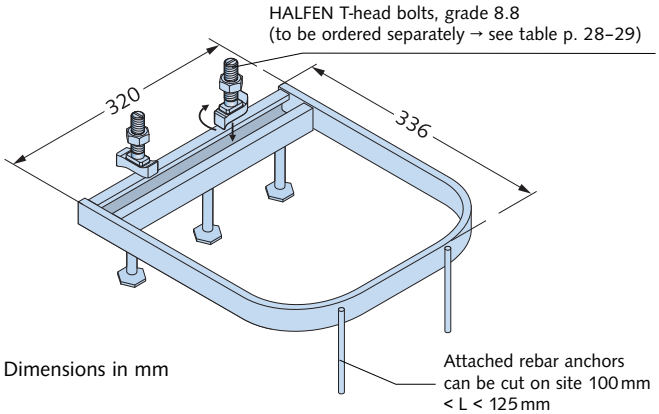
Design: High Shear Loading in Thin Slab Application

Typical installation



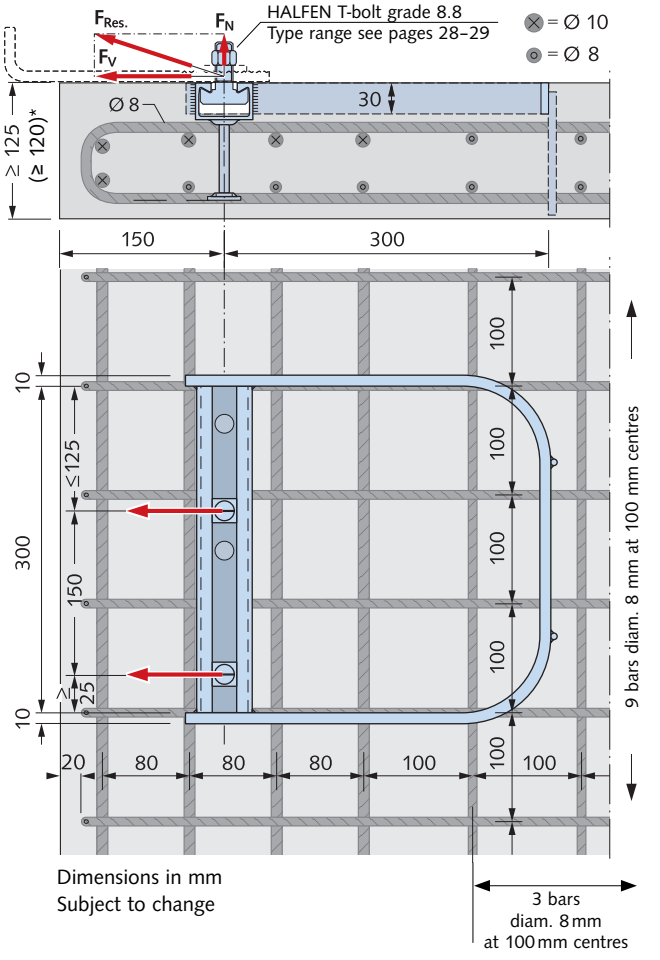
Product description

Product code: HCW 52/34
Material: 1.0038, hot-dip galvanized



Dimensions in mm

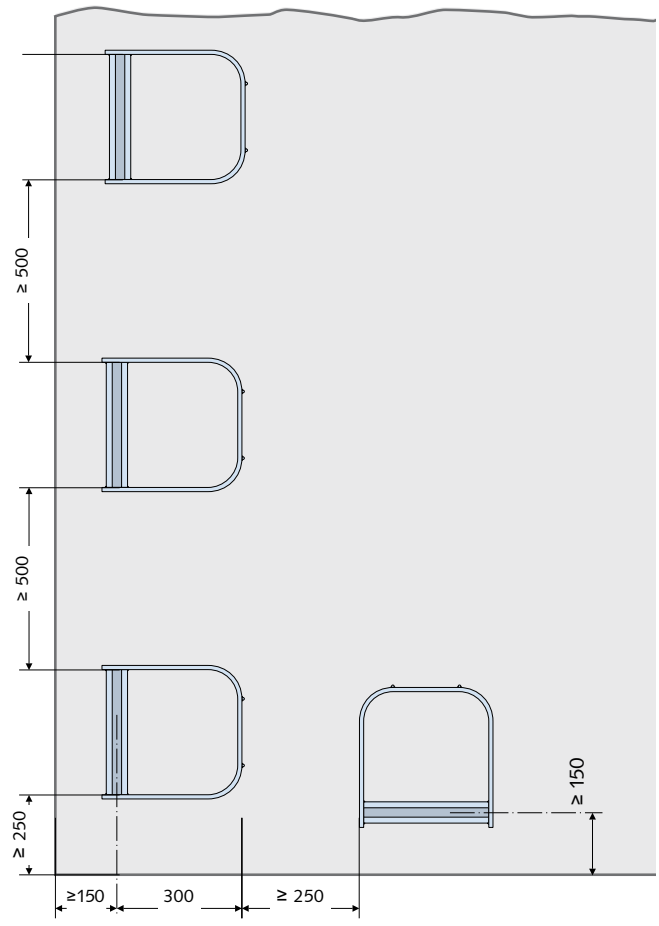
Reinforcement requirements



* Tested with slab thickness of 120mm at Tongji University/Shanghai

Note: Reinforcement required in grade 400 or higher.

Channel dimensions and positioning



Note: HALFEN HCW 52/34 can be manufactured with B6 Bolt anchors or alternatively with I-anchors.

Channel load data for HCW 52/34

A series of 3 tests produced the following average ultimate loads:

Ultimate test load:	$F_{V\ ultimate}$		= 142.3 kN
	$F_{N\ ultimate}$		= 47.4 kN
	$F_{result.\ ultimate}$	$= \sqrt{F_N^2 + F_V^2}$	= 150.0 kN

The adjacent load deformation diagram may be used to determine allowable loads based on acceptable displacement and the required safety factor according to local building codes. The diagram is based on the following:

- A concrete slab ≥ 125 mm thick and reinforced according to the diagram on the previous page.
- Concrete compression strength ≥ C20/25 N/mm² (cylinder/cube) with normal weight aggregate.
- Load is equally distributed to the channel by two HALFEN T-bolts (ordered separately) at an axial distance ≥ 150 mm. See below for sizes and load capacities.

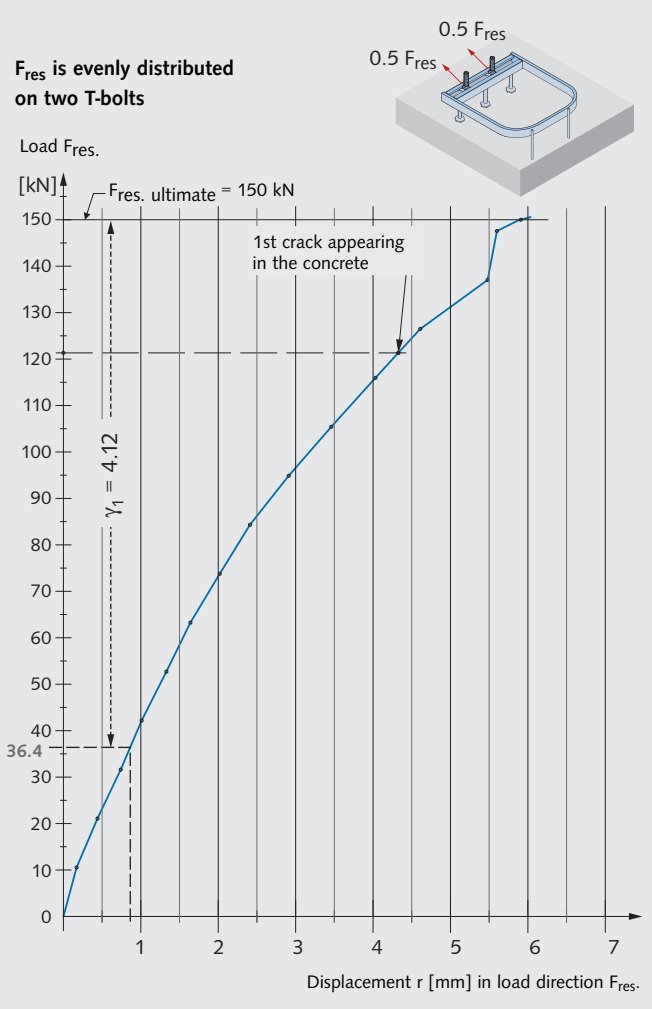
An example of a typical calculation method is shown below.
The factors used in the calculation example are for illustration only. Actual factors used on a project basis must be checked according to local or national building regulations. The calculations also make no allowance for load magnification caused by load eccentricities. These must be included according to the project design of the connection. Contact us for support if required.

Calculation Example:
(Assumed safety factor 3 applied to the ultimate test load)

Required working loads:	$F_{V\ work.}$	=	35 kN	
	$F_{N\ work.}$	=	10 kN	
Allowable loads at 3:1 safety factor:				
	$F_{V,\ allowed}$	=	47.4 kN	(142.3/3)
	$F_{N,\ allowed}$	=	15.8 kN	(47.43/3)
	$F_{res,\ allowed}$	=	50.0 kN	(150/3)
Checking	$F_{V\ work.}$	=	35 kN < 47.4 kN ✓ OK	
Checking	$F_{N\ work.}$	=	10 kN < 15.8 kN ✓ OK	
Checking	$F_{res.\ work.} = \sqrt{(10)^2 + (35)^2}$	=	36.4 kN < 50 kN ✓ OK	

Displacement at working load < 1 mm (see diagram).

Load deformation diagram



Actual safety factor to ultimate test load: γ_1 = (150 / 36.4) = 4.12

Fastener information

HALFEN T-bolts type HS 50/30 grade 8.8, M16 and M20 are recommended for use with HALFEN Channel type HCW 52/34 according to the load performance required. The loads $F_{S\ allow.}$ shown in the table below are per bolt and based on applied safety factors of approximately 2.5 : 1, other factors may be applied according to appropriate regulations and project requirements.

The tests were done at the "**Kölner Institut für Baustoffprüfung und -Technologie**" in Cologne/Germany and the **Tongji University Shanghai/China**. A copy of the test reports is available on request.

Type selection HALFEN T-head bolts HS 50/30 grade 8.8

Thread size	Material grade	Available lengths **L** [mm]	Bolt load (tension, angled pull and shear) $F_{S\ allow.}$ [kN]	Allowable bending moment [Nm]	Recommended initial torque [Nm]
M 16	8.8	40, 60, 80, 100	36.1	111	60
M 20	8.8	45, 60, 80, 100	56.4	216	120

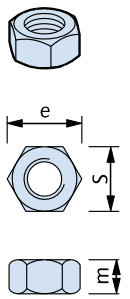
Please note that fastener performance may be limited by channel capacity.

T-bolts in other sizes and materials are available if required, please contact us for details. If slotted holes are used in the bracket to achieve tolerance transverse to the channel, the capacity of the T-bolts should be checked according to the allowable bending moment.

Accessories: Nuts, Washers

MU

Hexagonal nuts
DIN EN ISO 4032/
DIN 934

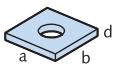
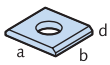
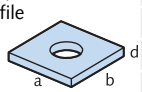
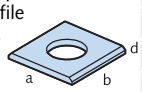
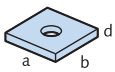


GV galvanized FK 8 thread	A4 stainless steel A4 thread	S/m DIN [mm]	S/m ISO [mm]	e [mm]
M 6	M 6	10/5	10/6	11.5
M 8	M 8	13/6.5	13/7.5	15.0
M 10	M 10	17/8	16/ 9.5	19.6
M 12	M 12	19/10	18/12	21.9
M 16	M 16	24/13	24/15.5	27.7
M 20	M 20	30/16	30/19	34.6
M 24		36/19	36/22	41.5

FV hot-dip galvanized thread	A2 stainless steel A2 thread	S/m DIN [mm]	S/m EN [mm]	e [mm]
M 6, M 8	M 8	13/6.5	13/7.5	15.0
M 10	M 10	17/08	16/ 9.5	19.6
M 12	M 12	19/10	18/12	21.9
M 16	M 16	24/13	24/15.5	27.7

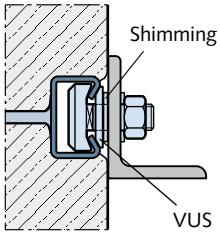
VUS

Square washers

	FV hot-dip galvanized for bolt	A4 stainless steel A4 for bolt	a x b x d [mm]
VUS 40/25 for profile 40/25; HZA 41/22 	M 10	M 10	40 x 40 x 5
	M 12	M 12	40 x 40 x 5
	M 16	M 16	40 x 40 x 5
VUS 49/30 for profile 54/33, 49/30 	M 10	M 10	37 x 37 x 5
	M 12	M 12	37 x 37 x 5
	M 16	M 16	37 x 37 x 5
	M 20	M 20	37 x 37 x 5
VUS 52/34 for profile 52/34, 50/30 	M 16	M 16	50 x 50 x 6
	M 20	M 20	50 x 50 x 6
VUS 72/49 for profile 72/48, 72/49 	M 20	M 20	54 x 54 x 6
	M 24	M 24	54 x 54 x 6
	M 27	M 27	54 x 54 x 6
	M 30	M 30	54 x 54 x 6
VUS 41/41 for all 41 profiles 	M 6	M 6	40 x 40 x 6
	M 10	M 10	40 x 40 x 6
	M 12	M 12	40 x 40 x 6

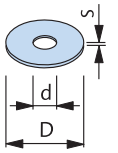
Ordering example: **VUS 52/34 - FV - M 20**

Application VUS:
for shimming non-flush installations.



US

Washers
DIN EN
ISO 7094/
DIN 9021/
DIN 440

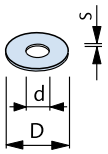


DIN	GV galvanized for bolt	A4 stainless steel A4 for bolt	D [mm]	d [mm]	s [mm]
440	M 6		22	6.6	2
9021	M 8	M 8	24	8.4	2
9021	M 10	M 10	30	10.5	2.5
440	M 12		45	13.5	4
9021	M 12	M 12	37	13	3
9021	M 16	M 16	50	17	3
440	M 20		72	22	6

Ordering example: **US - M 12 - GV -DIN 9021**

US

Washers
DIN EN
ISO 7089/
DIN 125



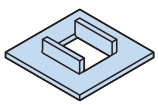
GV galvanized for bolt	A4 stainless steel A4 for bolt	D [mm]	d [mm]	s [mm]
M 6	M 6	12	6.4	1.6
M 8	M 8	16	8.4	1.6
M 10	M 10	21	10.5	2
M 12	M 12	24	13	2.5
M 16	M 16	30	17	3
M 20	M 20	37	21	3
M 24		44	25	4
		50	28	4
		56	31	4

FV hot-dip galvanized for bolt	A2 stainless steel A2 for bolt	D [mm]	d [mm]	s [mm]
	M 8	17	8.4	1.6
M 10	M 10	21	10.5	2
M 12	M 12	24	13	2.5
M 16	M 16	30	17	3

Ordering example: **US - M 12 - GV - DIN 125**

SIC

Locking washer

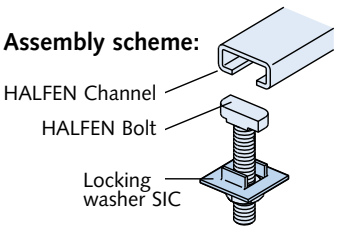


GV galvanized	A4 stainless steel A4	Suitable for HALFEN Bolts type	dimensions
SIC - 50/30 - gv	SIC - 50/30 - A4	50/30	M16, M20
SIC - 40/22 - gv	SIC - 40/22 - A4	38/17 40/22	M16
SIC - 38/23 - gv		38/23	M16
SIC - 29/20 - gv		29/20	M12
SIC - 38/17 - gv	SIC - 38/17 - A4	38/17 40/22	M12, M10
SIC - 28/15 - gv	SIC - 28/15 - A4	28/15	M8, M10
SIC - 20/12 - gv	SIC - 20/12 - A4	20/12	M8

Ordering example: **SIC - 38/17 - GV**

Application SIC:
For securing HALFEN Bolts; prevents bolts turning when tightening nuts.

Assembly scheme:



ACCESSORIES

Framing Channels

Heavy duty framing system

hot-rolled				cold-rolled			hot-rolled	cold-rolled		hot-rolled, serrated				
HM 72/48	HM 55/42	HM 52/34	HM 50/30	HM 49/30	HM / HL 50/40	HM 486	HM 40/22	HM 40/25	HM 422	HZM 64/44	HZM 53/34	HZM 41/27	HZM 38/23	HZM 29/20
72 / 33 / 48,5	54,5 / 26 / 42	52,5 / 22,5 / 33,5	49 / 22,5 / 30	50 / 22 / 30	49 / 22 / 39	48 / 22 / 27	39,5 / 18 / 23	40 / 18 / 25	39,5 / 18 / 21,5	64 / 26 / 44	52,5 / 22,5 / 34	40 / 18,5 / 27	38 / 18 / 23	29 / 14 / 20
HS / HSR 72/48, GWP 72/48	HS 50/30	HS / HSR 50/30, GWP 50/30		HS 50/30, GWP 50/30 bzw. GWP 50/40			HS / HSR 40/22, GWP 40/22			HZS 64/44	HZS 53/34	HZS 38/23	HZS 38/23, HS 38/17	HZS 29/20, HS 28/15

Medium duty framing system

cold-rolled	cold-rolled, serrated	cold-rolled		cold-rolled, serrated		cold-rolled	cold-rolled	
HM / HL 41/41	HZM / HZL 41/41	HM / HL 41/62	HM / HL 41/83	HZL 63/63	HZM / HZL 41/22	HM / HL 41/22	HLL 41/41	HLL 41/22
41 / 22 / 41	41 / 22 / 41	41 / 22 / 62	41 / 22 / 83	41 / 22 / 63	41 / 22 / 21	41 / 22 / 21	41 / 22 / 41	41 / 22 / 21
HZS/HS 41/41, HZS 41/22 GWP 41/41, GWP 41/22								

Light duty framing system

Cold-rolled						Cold-rolled
HM 36/36, HL 36/36	HM 38/17	HM 28/28, HL 28/28	HM 26/26, HL 26/26	HM 28/15, HL 28/15	HM 315	HM 20/12, HL 20/12
36 / 18 / 36	38 / 18 / 17,5	28 / 12 / 28	26 / 12	28 / 12 / 15	30 / 16 / 15	20 / 10 / 12
HS 38/17, GWP 38/17		HS 28/15, GWP 28/15			GWP 28/15	HS 20/12, GWP 20/12

Material and finishes

- Hot-dip galvanized FV or mill finish WB
- Sendzimir galvanized SV
- Stainless steel A4 1.4571/1.4404
- Stainless steel A2 1.4307
- Stainless steel HCR 1.4547/1.4529

Further information on materials and finishes → see page 12

HZM/HZL serrated profiles

REFERENCES

Infrastructure

International Curtain Wall Projects

Four Seasons, Mumbai


Regatta, Jakarta


Tanjong Pagar Centre, Singapore


Tamar, Hongkong


Post Tower, Bonn


National Bank, Dubai


Menara Bumiputra-Commerce, Kuala Lumpur


The Central, Singapore


Burj Khalifa, Dubai

432, Park Avenue, NYC

Grand Lisboa Hotel, Macao

The Capitol, Mumbai

Jin Mao / World Financial Center, Shanghai


Sudirman Plaza, Jakarta

Science Park II, Hongkong

Marina Bay Sands, Singapore

REFERENCES

Infrastructure

International Projects

High-Speed Railway construction:
- All major High-Speed Railway lines in Germany, e.g.:
  ICE line *Nuremberg – Leipzig* (→ "Finnetunnel");
  ICE line *Frankfurt – Cologne*
- All major High-Speed Railway lines
  in the Chinese network, e.g.:
  HSR *Wuhan – Guangzhou,* HSR *Beijing – Shanghai;*
  HSR *Hangzhou – Ningbo*
- High-Speed Railway line *Taipeh – Kaohsiung* / Taiwan
- High-Speed Railway line *Seoul – Pusan* / Korea

Airports
- Chek Lap Kok Airport, Hong Kong
- Singapore Changi International Airport, Terminal 3
- Doha International Airport
- New Bangkok International Airport (Suvarnabhumi)

Stadiums
- Letzigrund, Zurich / Switzerland
- Wimbledon, Court No. 1, London / UK
- St. Jacob Park, Basel / Switzerland
- Stade de Suisse, Bern / Switzerland
- RheinEnergieStadion, Cologne / Germany
- Parc des Princes, Paris / France

Power plants
- Daya Bay NPP, Guangdong / China
- Sizewell B PWR, Leiston / UK
- Ringhals NPP, Gothenburg / Sweden
- Olkiluoto 3 NPP, Rauma / Finland
- Taishan NPP, Guangdong / China

Subway and station construction
- MTR, Hong Kong
- MRT, Singapore
- Metro, Shenzhen / China
- Metro, Taipeh / Taiwan
- Railway station, Wuhan / China
- Lehrter Bahnhof (Main Train Station), Berlin/ Germany

Utility tunnels & Research facilities
- BEWAG Tunnel
- Research and testing facilities, e.g.:
  European XFEL research facility, Hamburg / Germany;
  CERN LHC Tunnel, Geneva / Switzerland

Precast construction
- ECC Shell project, Singapore
- HDB housing projects, Singapore
- Airbus assembly- and painting hangar, Stade / Germany

Traffic Control Tower, Mumbai


BEWAG HV utility tunnel, Berlin

Stadion Letzigrund, Switzerland


Sage Centre, Gateshead (UK)


Airport Hong Kong


ECC Shell Singapore


Nuclear power plant, Dalian


Finnetunnel, Germany

For further information please contact: www.halfen.com

B - 046 - E - 08/17 PDF 08/17