Hilti HAC Anchor Channel
with HBC-C / HBC-C-N T-Head Bolt

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Customer Hotline

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Anchor channel HAC

Applications
- Fastening curtain wall brackets
- Installation of building services in the basement backbone, risers and backbones for each level
- Floor or ceiling grid system for application with demanding requirements in terms of flexibility and dust or noise reduction e.g. data center
- Main runs of pipes or ducts for heating, plumbing, ventilation and air conditioning

Advantages
- Innovative V-shape provides high load resistance and close edge distances
- Faster installation of building services than with traditional anchor fastening method
- Dustless and noiseless fastening method
- Flexibility of use throughout the whole building life cycle

Technical data	
Base Material	Concrete
Environmental conditions	Indoor, damp conditions
Material composition	Steel, Hot-dip galvanized

HAC-40

Ordering designation	Length, l_{ch}	Number of anchors	Anchor distance	standard embedment depth, h_{ef}	Sales pack quantity	Item number
HAC-40 91/200 F	200 mm	2	150 mm	91 mm	1 pc	**2122491**[1]
HAC-40 91/350 F	350 mm	3	150 mm	91 mm	1 pc	**2122493**
HAC-40 91/550 F	550 mm	3	250 mm	91 mm	1 pc	**2122495**[1]
HAC-40 91/1050 F	1050 mm	5	250 mm	91 mm	1 pc	**2122497**[1]
HAC-40 91/1300 F	1300 mm	6	250 mm	91 mm	1 pc	**2122498**[1]
HAC-40 91/1550 F	1550 mm	7	250 mm	91 mm	1 pc	**2122499**[1]
HAC-40 91/1800 F	1800 mm	8	250 mm	91 mm	1 pc	**2122530**[1]
HAC-40 91/2050 F	2050 mm	9	250 mm	91 mm	1 pc	**2122531**[1]
HAC-40 91/2300 F	2300 mm	10	250 mm	91 mm	1 pc	**2122532**[1]
HAC-40 91/5800 F	5800 mm	24	250 mm	91 mm	1 pc	**2122536**[1]

[1] This is a non-stock item. For detailed lead time information please contact your Hilti representative.

HAC-50

Ordering designation	Length, l_{ch}	Number of anchors	Anchor distance	standard embedment depth, h_{ef}	Sales pack quantity	Item number
HAC-50 106/200 F	200 mm	2	150 mm	106 mm	1 pc	**2122537**[1]
HAC-50 106/350 F	350 mm	3	150 mm	106 mm	1 pc	**2122539**
HAC-50 106/450 F	450 mm	3	200 mm	106 mm	1 pc	**2122540**[1]
HAC-50 106/550 F	550 mm	3	250 mm	106 mm	1 pc	**2122541**[1]
HAC-50 106/1050 F	1050 mm	5	250 mm	106 mm	1 pc	**2122543**[1]
HAC-50 106/2300 F	2300 mm	10	250 mm	106 mm	1 pc	**2122548**[1]
HAC-50 106/5800 F	5800 mm	24	250 mm	106 mm	1 pc	**2122553**[1]

[1] This is a non-stock item. For detailed lead time information please contact your Hilti representative.

HAC-60

Ordering designation	Length, l_{ch}	Number of anchors	Anchor distance	standard embedment depth, h_{ef}	Sales pack quantity	Item number
HAC-60 148/350 F	350 mm	3	150 mm	148 mm	1 pc	**431851**
HAC-60 148/450 F	450 mm	3	200 mm	148 mm	1 pc	**431852**[1]
HAC-60 148/550 F	550 mm	3	250 mm	148 mm	1 pc	**431853**[1]
HAC-60 148/1050 F	1050 mm	5	250 mm	148 mm	1 pc	**431854**[1]
HAC-60 148/2300 F	2300 mm	10	250 mm	148 mm	1 pc	**431855**[1]
HAC-60 148/5800 F	5800 mm	24	250 mm	148 mm	1 pc	**431856**[1]

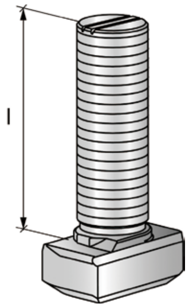
[1] This is a non-stock item. For detailed lead time information please contact your Hilti representative.

HAC-70

Ordering designation	Length, l_{ch}	Number of anchors	Anchor distance	standard embedment depth, h_{ef}	Sales pack quantity	Item number
HAC-70 175/350 F	350 mm	3	150 mm	175 mm	1 pc	**431861**
HAC-70 175/450 F	450 mm	3	200 mm	175 mm	1 pc	**431862**
HAC-70 175/550 F	550 mm	3	250 mm	175 mm	1 pc	**431863**[1]
HAC-70 175/1050 F	1050 mm	5	250 mm	175 mm	1 pc	**431864**[1]
HAC-70 175/2300 F	2300 mm	10	250 mm	175 mm	1 pc	**431865**[1]
HAC-70 175/5800 F	5800 mm	24	250 mm	175 mm	1 pc	**431866**[1]

[1] This is a non-stock item. For detailed lead time information please contact your Hilti representative.

T-head bolt HBC-C



Applications

- For use with HAC-40 to HAC-70 anchor channels

Advantages

- Simplification of the range available Only one universal bolt type needed to cover HAC-40 to HAC-70 anchor channels
- European approval according to latest technical specifications
- Dustless and noiseless fastening method

Hot-dip galvanized HBC-C

Technical data	
Environmental conditions	Indoor, damp conditions
Material composition	Steel, 8.8 grade, hot-dip galvanized (min. 45 µm)
Material, corrosion	Steel, sherardized / hot-dip galvanized

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Ordering designation	Anchor size	Useable thread length*	Bolt length, l	Sales pack quantity	Item number
HBC-C M12x60 8.8F	M12	51 mm	60 mm	100 pc	**2095646**
HBC-C M12x80 8.8F	M12	71 mm	80 mm	100 pc	**2095647**
HBC-C M12x100 8.8F	M12	91 mm	100 mm	100 pc	**2095648**[1)]
HBC-C M16x60 8.8F	M16	50 mm	60 mm	100 pc	**2095650**
HBC-C M16x80 8.8F	M16	70 mm	80 mm	50 pc	**2095651**
HBC-C M16x100 8.8F	M16	90 mm	100 mm	50 pc	**2095652**
HBC-C M20x60 8.8F	M20	48 mm	60 mm	50 pc	**2095653**[1)]
HBC-C M20x80 8.8F	M20	68 mm	80 mm	50 pc	**2095654**[1)]
HBC-C M20x100 8.8F	M20	88 mm	100 mm	50 pc	**2095655**

[1)] This is a non-stock item. For detailed lead time information please contact your Hilti representative.
* Useable thread length meauses the useable thread length after inserted the HBC-C into HAC

Hot-dip galvanized HBC-C-N

Technical data	
Environmental conditions	Indoor, damp conditions
Type of fastening	Pre-fastening
Tooth configuration	Notched
Material, corrosion	Steel, sherardized / hot-dip galvanized

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Ordering designation	Anchor size	Useable thread length[2)]	Bolt length, l	Sales pack quantity	Item number
HBC-C-N M16x60 8.8F	M16	41 mm	50 mm	25 pc	**2019736**
HBC-C-N M16x80 8.8F	M16	71 mm	80 mm	25 pc	**433479**

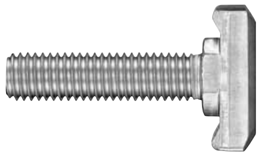
[1)] This is a non-stock item. For detailed lead time information please contact your Hilti representative.
[2)] Useable thread length meauses the useable thread length after inserted the HBC-C into HAC

Ordering designation	Anchor size	Useable thread length[2]	Bolt length, l	Sales pack quantity	Item number
HBC-C-N M16x100 8.8F	M16	91 mm	100 mm	25 pc	**2019737**
HBC-C-N M20x60 8.8F	M20	48 mm	60 mm	50 pc	**434345**
HBC-C-N M20x80 8.8F	M20	68 mm	80 mm	50 pc	**2019739**
HBC-C-N M20x100 8.8F	M20	88 mm	100 mm	50 pc	**434346**[1]
HBC-C-N M20x150 8.8F	M20	138 mm	150 mm	25 pc	**2019820**[1]

[1] This is a non-stock item. For detailed lead time information please contact your Hilti representative.
[2] Useable thread length meauses the useable thread length after inserted the HBC-C into HAC

T-head bolt (Stainless steel) HBC-C

Technical data	
Environmental conditions	Outdoor
Material composition	Steel, A4
Material, corrosion	Steel, stainless



Info | Shop

Ordering designation	Anchor size	Useable thread length*	Bolt length, l	Sales pack quantity	Item number
HBC-C M12x50 50R	M12	41 mm	50 mm	25 pc	**433465**[1]
HBC-C M12x80 50R	M12	71 mm	80 mm	25 pc	**433466**[1]
HBC-C M16x60 50R	M16	50 mm	60 mm	50 pc	**433472**[1]
HBC-C M16x80 50R	M16	70 mm	80 mm	25 pc	**433474**[1]

[1] This is a non-stock item. For detailed lead time information please contact your Hilti representative.
* Useable thread length meauses the useable thread length after inserted the HBC-C into HAC

Specification

HAC

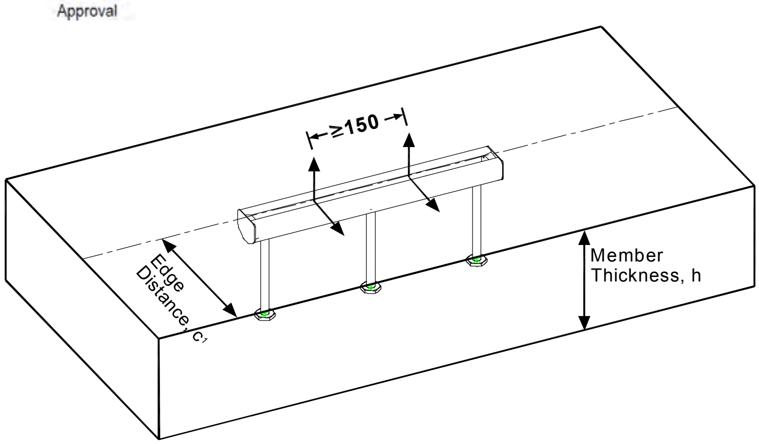
	HAC 40	HAC 50	HAC 60	HAC 70
Material of channel	Carbon steel S235, EN 10025-2	Carbon steel S235, EN 10025-2	Carbon steel S235, EN 10025-2	Carbon steel S235, EN 10025-2
Coating thickness	Hot-dip gal. ≥ 55µm, EN ISO 1461: 2009 -10	Hot-dip gal. ≥ 55µm, EN ISO 1461: 2009 - 10	Hot-dip gal. ≥ 70µm, EN ISO 1461: 2009 - 10	Hot-dip gal. ≥ 70µm, EN ISO 1461: 2009 - 10
Channel width	40.5mm	41.5mm	43mm	44.5mm
Channel height	28mm	31mm	35.5mm	40mm
Embedment depth	91mm	106mm	148mm	175mm
Recommended tensile load	16.7kN	22kN	34.7kN	48.7kN
Recommended shear load	23.3kN	34kN	44.7kN	52.7kN

HBC-C & HBC-C-N

	Grade 8.8	Stainless steel, A4-50
Material of T Bolt	Carbon steel grade 8.8, EN ISO 898-1	Stainless steel, A4-50
Coating thickness	hot-dip gal. ≥ 45µm, ISO 1461:1999	N/A

Basic Loading Data (Paired Load)

- All data given in this section according ETA-11/0006, issue 2011-02-08.
- Channel length: 350mm with 3 anchors (legs)
- Embedment depth, h_{ef} = 91mm.
- T-head bolts spacing ≥ 150mm, choose of bolt size according to bolt selection chart.
- Linear interpolation is now allowed. Consult Hilti technical advisory for loading with different edge distance or member thickness.
- Concrete C35/45, f_{ck} = 45N/mm^2 Consult Hilti technical advisory for loading with different concrete grade.
- The recommended load with overall global safety factor, γ_{global}, 3. Loads may vary according to the safety factor requirement from national regulations.
- Quick selection of channel only. Consult Hilti technical advisory for combined load checking.
- Parallel paired channel spacing = 2 x edge distance c_1
- For detail design, please see HAC design manual.



HAC 40

Characteristic Resistance

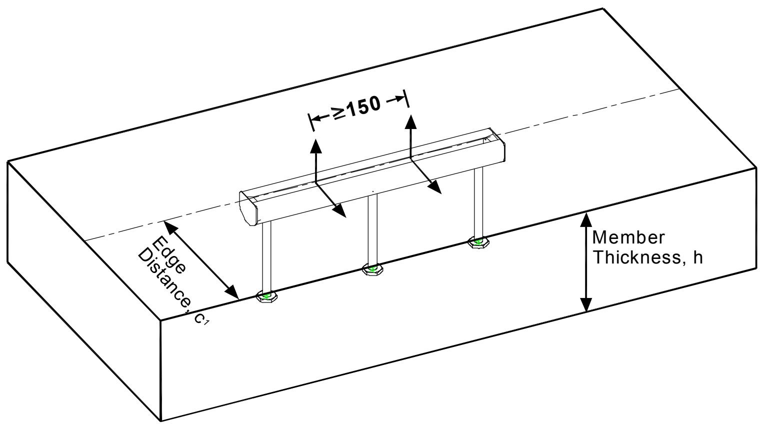
	Concrete member thickness, h [mm]					Edge distance, c_1 [mm]
	125	150	200	250	300	
Tension [kN]	50.0	50.0	50.0	50.0	50.0	200
Shear [kN]	64.0	70.0	70.0	70.0	70.0	
Tension [kN]	50.0	50.0	50.0	50.0	50.0	150
Shear [kN]	49.0	53.0	62.0	69.8	70.0	
Tension [kN]	50.0	50.0	50.0	50.0	50.0	125
Shear [kN]	41.6	45.5	52.8	59.0	64.8	
Tension [kN]	50.0	50.0	50.0	50.0	50.0	100
Shear [kN]	34.0	37.0	43.0	48.3	48.9	
Tension [kN]	50.0	50.0	50.0	50.0	50.0	75
Shear [kN]	26.0	29.0	33.0	34.2	34.1	
Tension [kN]	41.0	44.0	44.0	44.0	44.0	50
Shear [kN]	18.0	20.0	21.0	21.0	21.0	

Recommended Load

	Concrete member thickness, h [mm]					Edge distance, c_1 [mm]
	125	150	200	250	300	
Tension [kN]	16.7	16.7	16.7	16.7	16.7	200
Shear [kN]	21.3	23.3	23.3	23.3	23.3	
Tension [kN]	16.7	16.7	16.7	16.7	16.7	150
Shear [kN]	16.3	17.7	20.7	23.3	23.3	
Tension [kN]	16.7	16.7	16.7	16.7	16.7	125
Shear [kN]	13.9	15.2	17.6	19.7	21.6	
Tension [kN]	16.7	16.7	16.7	16.7	16.7	100
Shear [kN]	11.3	12.3	14.3	16.1	16.3	
Tension [kN]	16.7	16.7	16.7	16.7	16.7	75
Shear [kN]	8.7	9.7	11.0	11.4	11.4	
Tension [kN]	13.7	14.7	14.7	14.7	14.7	50
Shear [kN]	6.0	6.7	7.0	7.0	7.0	

Basic Loading Data (Paired Load)

- All data given in this section according ETA-11/0006, issue 2011-02-08.
- Channel length: 350mm with 3 anchors (legs)
- Embedment depth, h_{ef} = 106mm.
- T-head bolts spacing ≥ 150mm, choose of bolt size according to bolt selection chart.
- Linear interpolation is now allowed. Consult Hilti technical advisory for loading with different edge distance or member thickness.
- Concrete C35/45, f_{ck} = 45N/mm^2 Consult Hilti technical advisory for loading with different concrete grade.
- The recommended load with overall global safety factor, γ_{global}, 3. Loads may vary according to the safety factor requirement from national regulations.
- Quick selection of channel only. Consult Hilti technical advisory for combined load checking.
- Parallel paired channel spacing = 2 x edge distance c_1
- For detail design, please see HAC design manual.



HAC 50

For detail design, see HAC design manual

Characteristic Resistance

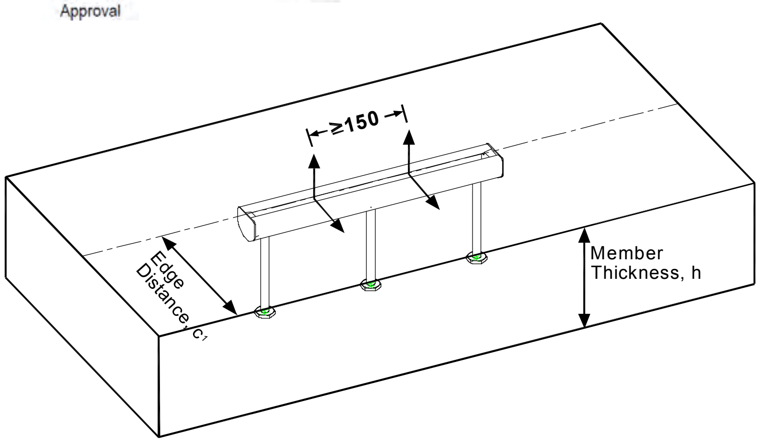
	Concrete member thickness, h [mm]					Edge distance, c_1 [mm]
	125	150	200	250	300	
Tension [kN]	66.0	66.0	66.0	66.0	66.0	300
Shear [kN]	93.0	102.0	102.0	102.0	102.0	
Tension [kN]	66.0	66.0	66.0	66.0	66.0	200
Shear [kN]	63.5	69.8	80.0	90.0	98.0	
Tension [kN]	66.0	66.0	66.0	66.0	66.0	150
Shear [kN]	48.5	53.4	61.0	69.0	75.0	
Tension [kN]	66.0	66.0	66.0	66.0	66.0	125
Shear [kN]	41.4	45.3	53	58.5	64.05	
Tension [kN]	66.0	66.0	66.0	66.0	66.0	100
Shear [kN]	33.5	37.0	42.5	47.8	49.0	
Tension [kN]	64.0	64.0	64.0	64.0	64.0	75
Shear [kN]	26.0	28.8	33.0	34.0	34.0	

Recommended Load

	Concrete member thickness, h [mm]					Edge distance, c_1 [mm]
	125	150	200	250	300	
Tension [kN]	22.0	22.0	22.0	22.0	22.0	300
Shear [kN]	31.0	34.0	34.0	34.0	34.0	
Tension [kN]	22.0	22.0	22.0	22.0	22.0	200
Shear [kN]	21.2	23.3	26.7	30.0	32.7	
Tension [kN]	22.0	22.0	22.0	22.0	22.0	150
Shear [kN]	16.2	17.8	20.3	23.0	25.0	
Tension [kN]	22.0	22.0	22.0	22.0	22.0	125
Shear [kN]	13.8	15.1	17.7	19.5	21.4	
Tension [kN]	22.0	22.0	22.0	22.0	22.0	100
Shear [kN]	11.2	12.3	14.2	15.9	16.3	
Tension [kN]	21.3	21.3	21.3	21.3	21.3	75
Shear [kN]	8.7	9.6	11.0	11.3	11.3	

Basic Loading Data (Paired Load)

- All data given in this section according ETA-11/0006, issue 2011-02-08.
- Channel length: 350mm with 3 anchors (legs)
- Embedment depth, h_{ef} = 148mm.
- T-head bolts spacing ≥ 150mm, choose of bolt size according to bolt selection chart.
- Linear interpolation is now allowed. Consult Hilti technical advisory for loading with different edge distance or member thickness.
- Concrete C35/45, f_{ck} = 45N/mm^2 Consult Hilti technical advisory for loading with different concrete grade.
- The recommended load with overall global safety factor, γ_{global}, 3. Loads may vary according to the safety factor requirement from national regulations.
- Quick selection of channel only. Consult Hilti technical advisory for combined load checking.
- Parallel paired channel spacing = 2 x edge distance c_1
- For detail design, please see HAC design manual.



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Characteristic Resistance

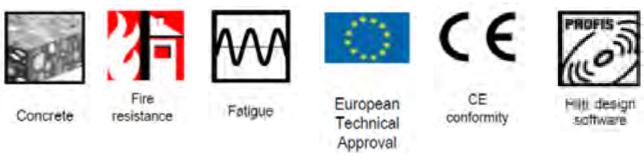
	Concrete member thickness, h [mm]					Edge distance, c_1 [mm]
	170	200	250	300	350	
Tension [kN]	104.0	104.0	104.0	104.0	104.0	350
Shear [kN]	125.0	134.0	134.0	134.0	134.0	
Tension [kN]	104.0	104.0	104.0	104.0	104.0	250
Shear [kN]	90.0	98.0	110.0	120.0	130.5	
Tension [kN]	104.0	104.0	104.0	104.0	104.0	200
Shear [kN]	73.0	79.0	89.3	97.0	105.8	
Tension [kN]	104.0	104.0	104.0	104.0	104.0	150
Shear [kN]	56.0	60.5	68.3	74.0	80.6	
Tension [kN]	104.0	104.0	104.0	104.0	104.0	125
Shear [kN]	47.6	51.4	57.6	63	65.5	
Tension [kN]	102.0	104.0	104.0	104.0	104.0	100
Shear [kN]	38.5	41.5	47.0	48.5	48.9	

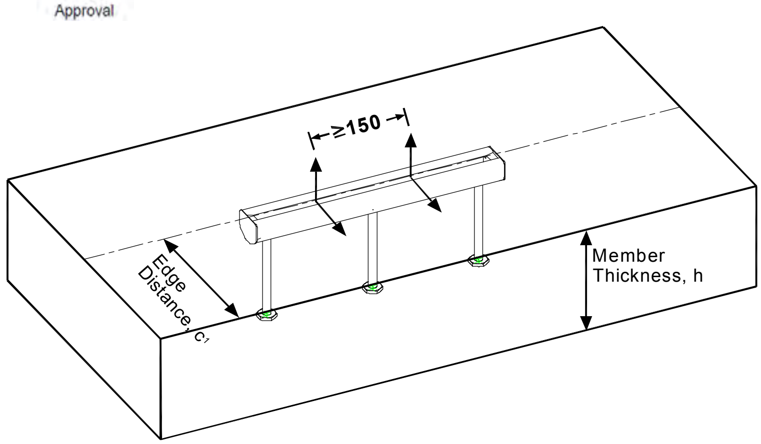
Recommended Load

	Concrete member thickness, h [mm]					Edge distance, c_1 [mm]
	170	200	250	300	350	
Tension [kN]	34.7	34.7	34.7	34.7	34.7	350
Shear [kN]	41.7	44.7	44.7	44.7	44.7	
Tension [kN]	34.7	34.7	34.7	34.7	34.7	250
Shear [kN]	30.0	32.7	36.7	40.0	43.5	
Tension [kN]	34.7	34.7	34.7	34.7	34.7	200
Shear [kN]	24.3	26.3	29.8	32.3	35.3	
Tension [kN]	34.7	34.7	34.7	34.7	34.7	150
Shear [kN]	18.7	20.2	22.8	24.7	26.9	
Tension [kN]	34.7	34.7	34.7	34.7	34.7	125
Shear [kN]	15.9	17.1	19.2	21.0	21.8	
Tension [kN]	34.0	34.7	34.7	34.7	34.7	100
Shear [kN]	12.8	13.8	15.7	16.2	16.3	

Basic Loading Data (Paired Load)

- All data given in this section according ETA-11/0006, issue 2011-02-08.
- Channel length: 350mm with 3 anchors (legs)
- Embedment depth, h_{ef} = 175mm.
- T-head bolts spacing ≥ 150mm, choose of bolt size according to bolt selection chart.
- Linear interpolation is now allowed. Consult Hilti technical advisory for loading with different edge distance or member thickness.
- Concrete C35/45, f_{ck} = 45N/mm^2 Consult Hilti technical advisory for loading with different concrete grade.
- The recommended load with overall global safety factor, γ_{global}, 3. Loads may vary according to the safety factor requirement from national regulations.
- Quick selection of channel only. Consult Hilti technical advisory for combined load checking.
- Parallel paired channel spacing = 2 x edge distance c_1
- For detail design, please see HAC design manual.





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Characteristic Resistance

	Concrete member thickness, h [mm]					Edge distance, c_1 [mm]
	200	250	300	350	400	
Tension [kN]	146.0	146.0	146.0	146.0	146.0	350
Shear [kN]	135.0	151.4	158.0	158.0	158.0	
Tension [kN]	146.0	146.0	146.0	146.0	146.0	250
Shear [kN]	97.5	109.2	119.0	129.8	138.0	
Tension [kN]	146.0	146.0	146.0	146.0	146.0	200
Shear [kN]	78.5	88.6	96.0	104.8	111.0	
Tension [kN]	146.0	146.0	146.0	146.0	146.0	150
Shear [kN]	60.0	67.3	73.5	79.6	82.5	
Tension [kN]	146.0	146.0	146.0	146.0	146.0	125
Shear [kN]	51.0	56.7	62.2	65.2	65.2	
Tension [kN]	136.5	143.0	143.0	143.0	143.0	100
Shear [kN]	41.0	46.2	49.0	49.0	49.0	

Recommended Load

	Concrete member thickness, h [mm]					Edge distance, c_1 [mm]
	200	250	300	350	400	
Tension [kN]	48.7	48.7	48.7	48.7	48.7	350
Shear [kN]	45.0	50.5	52.7	52.7	52.7	
Tension [kN]	48.7	48.7	48.7	48.7	48.7	250
Shear [kN]	32.5	36.4	39.7	43.3	46.0	
Tension [kN]	48.7	48.7	48.7	48.7	48.7	200
Shear [kN]	26.2	29.5	32.0	34.9	37.0	
Tension [kN]	48.7	48.7	48.7	48.7	48.7	150
Shear [kN]	20.0	22.4	24.5	26.5	27.5	
Tension [kN]	48.7	48.7	48.7	48.7	48.7	125
Shear [kN]	17.0	18.9	20.7	21.7	21.7	
Tension [kN]	45.5	47.7	47.7	47.7	47.7	100
Shear [kN]	13.7	15.4	16.3	16.3	16.3	

Basic Loading Data

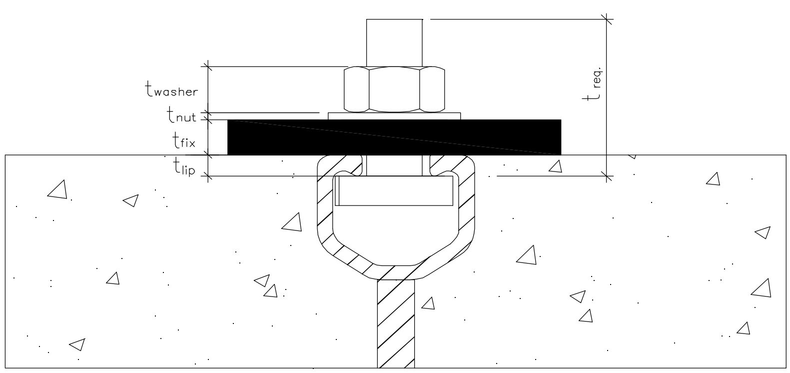
- All data for HBC-C & HBC-C-N Bolt given in this section according ETA-11/0006, issue 2011-02-08
- The recommended load with overall global safety factor, γ_{global}, 3. Loads may vary according to the safety factor requirement from national regulations.
- For detail design, please see HAC design manual

HBC-C & HBC-C-N Bolt
Characteristic Resistance (single bolt)

		M12	M16	M20	Material
Tension	**[kN]**	**67.4**	**125.6**	**196.0**	**8.8**
Shear	**[kN]**	**33.7**	**62.7**	**97.9**	
Tension	**[kN]**	**42.2**	**78.5**	**122.5**	**A4-50**
Shear	**[kN]**	**25.3**	**47.0**	**73.4**	

Recommended Load (single bolt)

		M12	M16	M20	Material
Tension	**[kN]**	**22.5**	**41.9**	**65.3**	**8.8**
Shear	**[kN]**	**11.2**	**20.9**	**32.6**	
Tension	**[kN]**	**14.1**	**26.2**	**40.8**	**A4-50**
Shear	**[kN]**	**8.4**	**15.7**	**24.5**	



$$L_{req.} = t_{lip} + t_{fix} + t_{nut} + t_{washer} + 3 - 5 \text{ no. of threads *}$$

* - 3 - 5 nos. of thread is the common practice.

Model	t_{lip} [mm]
HAC 40	**4.5**
HAC 50	**5.3**
HAC 60	**6.3**
HAC 70	**7.4**

Nut	t_{nut} [mm]
for M12	**9**
for M16	**14**
for M20	**17**

Washer	t_{washer} [mm]
M12	**~ 3**
M16	**~ 4**
M20	**~ 6**

Hilti Anchor Channel

Fastening Technology Manual

Important notice

1. The information and recommendations given herein are based on the principles, formulae and safety factors set out in the Hilti technical instructions, the operating manuals, the setting instructions, the installation manuals and other data sheets that are believed to be correct at the time of writing. The data and values are based on the respective characteristic data obtained from tests under laboratory or other controlled conditions. It is the user's responsibility to use the data given in the light of conditions on site and taking into account the intended use of the products concerned. The user has to check the listed prerequisites and criteria conform to the conditions actually existing on the job-site. Whilst Hilti can give general guidance and advice, the nature of Hilti products means that the ultimate responsibility for selecting the right product for a particular application must lie with the customer.
2. All products must be used, handled and applied strictly in accordance with all current instructions for use published by Hilti, i.e. technical instructions, operating manuals, setting instructions, installation manuals and others.
3. All products are supplied and advice is given subject to the Hilti terms of business.
4. Hilti's policy is one of continuous development. We therefore reserve the right to alter specifications, etc. without notice.
5. The given characteristic data in the Anchor Channel Fastening Technology Manual reflect actual test results and are thus valid only for the indicated test conditions.
6. Hilti is not obligated for direct, indirect, incidental or consequential damages, losses or expenses in connection with, or by reason of, the use of, or inability to use the products for any purpose. Implied warranties of merchantability or fitness for a particular purpose are specially excluded.

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Content

1 Introduction

In over 60 years Hilti has acquired tremendous know-how and gained worldwide acceptance as a reliable partner in the field of fastening systems. Being an innovative company, our foremost goal is to provide innovative, well-engineered products. Accordingly, we now offer an extensive cast-in anchor channel portfolio for a wide range of applications.

Anchor channel systems have been awarded approvals by Germany's DIBt (Deutsches Institut für Bautechnik) since the 1970s. Based on the state of the art at that time, these approvals represented a great step forward toward use of approved and reliable systems. But over the past few years the approach to the use of cast-in parts in the construction industry has changed tremendously.

Up to now, the design of these systems has been based on tables. The load values given in these tables represent steel failure. This often results in systems being massively over-designed and boundary conditions are chosen to ensure that concrete failure cannot be expected. Today, in a world where cost-efficient design is absolutely crucial and natural resources such as the iron that goes into making steel are considered increasingly precious, the demand for better material utilization has grown. In recent years, a better understanding of various anchor channel failure modes has also been gained. Intensive research and testing has now yielded a new design method that elevates anchor channel design to the level of anchor design. A side effect of this new design method is the requirement for a complex calculation and verification model. All possible failure modes are taken into consideration during the verification process. This new design method thus fits perfectly in today's new generation of building codes utilizing the partial safety factor concept.

CEN-TS 1992-4 in combination with a European Technical Approval forms the basis for safe and economical as well as detailed anchor channel design.

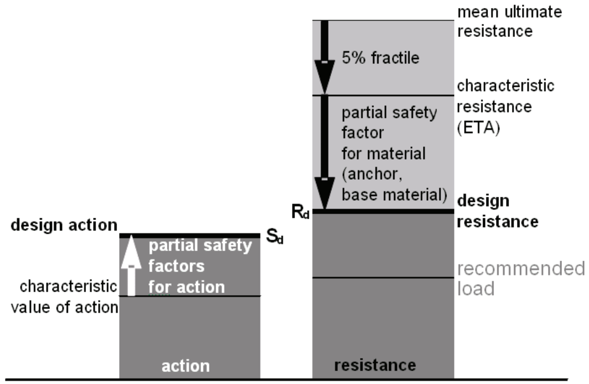
This manual refers to

- Static tensile loads as well as lateral and longitudinal shear loads in both cracked and un-cracked concrete from C12/15 through C90/105
- Load values in the event of fire for cracked concrete grade C20/25
- Fatigue loads in both cracked and un-cracked concrete from C12/15 through C90/105

The specification of anchor channels in accordance with CEN demands use of flexible, up-to-date software that lets engineers work efficiently. PROFIS Anchor Channel, the new PC application from Hilti, meets these requirements admirably.

1.1 Safety concept

Partial safety factor concept



For anchor channels for use in concrete with European Technical Approval (ETA) the partial safety factor concept according to the Common Understanding of Assessment Procedure, CUAP 06.01/01:2010 and CEN/TS 1992-4:2009 for static loads and CUAP 06.01/01:2010, Annex A for fatigue loads shall be applied. It must be shown that the value of design actions does not exceed the value of the design resistance:

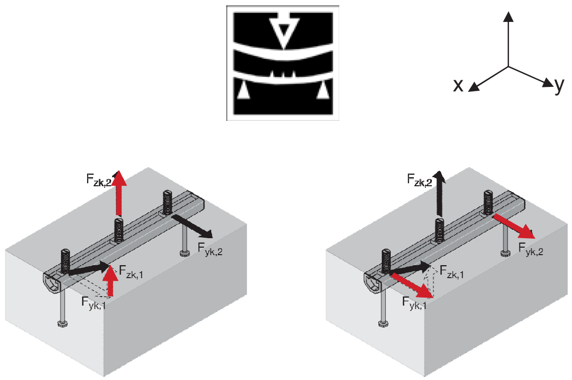
$S_d \leq R_d$.

As for the characteristic resistance given in the respective ETA, reduction factors due to e.g. application conditions are already considered.

2 Required verifications

2.1 CEN design method

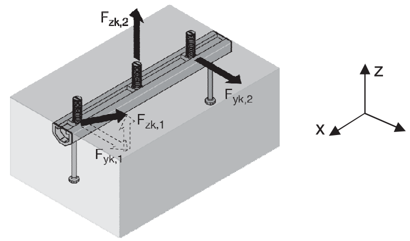
Tension / shear



3 Anchor channel design for static loads

3.1 Determination of forces acting on screws

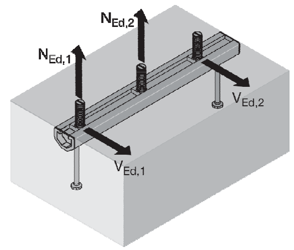
3.1.1 External loads



External moments need to be translated into forces acting on screws.

3.1.2 Loads acting on screw

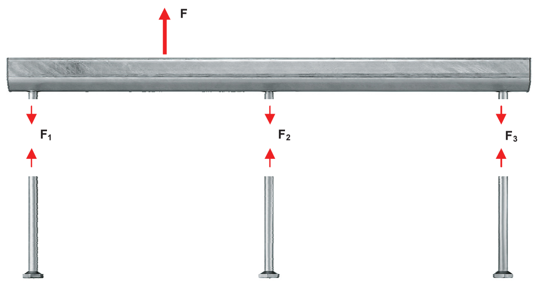
$$V_{Ed,i} = F_{yk,G,i} \cdot \gamma_G + F_{yk,Q,i} \cdot \gamma_Q$$
$$N_{Ed,i} = F_{zk,G,i} \cdot \gamma_G + F_{zk,Q,i} \cdot \gamma_Q$$



$F_{yk,G,i}$ / $F_{zk,G,i}$:	Characteristic dead load acting on screw i
$F_{yk,Q,i}$ / $F_{zk,Q,i}$:	Characteristic live load acting on screw i
γ_G:	Partial safety factor dead load
γ_Q:	Partial safety factor live load

3.2 Determination of forces acting on anchors

For several verifications it is necessary to know the loads acting on the anchors F_i. This requires a distribution of the loads acting on the screws into loads acting on the anchors. Anchor channels with two anchors (short pieces) allow a simplification with the assumption of a simply supported beam with a span length equal to the anchor spacing. In case of more than two anchors a triangular load distribution is assumed. Anchor forces can be determined on this basis separately for both tension and shear.



3.2.1 Anchor channel with more than 2 anchors

$$N^a_{Ed,i} = k \cdot A_i' \cdot N_{Ed}$$

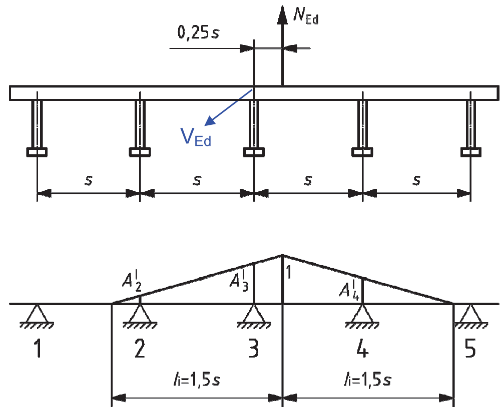
$$V^a_{Ed,i} = k \cdot A_i' \cdot V_{Ed}$$

A'_i ... Ordinate at the position of the anchor i of a triangle with the unit height at the position of load N and the base length $2l_i$

n ... Number of anchors on the channel within the influence length l_i to either side of the applied load N_{ed} / V_{ed} on special screw

I_y ... Moment of inertia of the channel [mm^4], as a simplification used both for distribution of tensile and shear forces

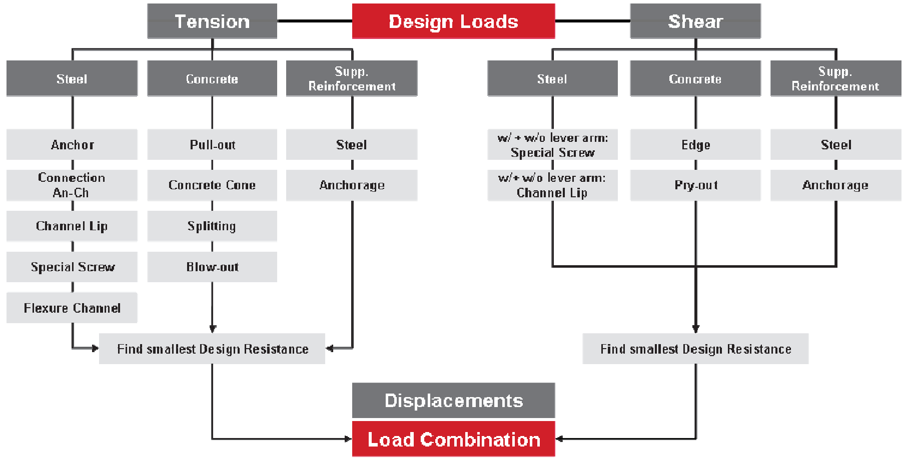
s ... Anchor spacing [mm]



$$k = \frac{1}{\sum_1^n A_i'}$$

Principle: Theorem on intersecting lines (A) with weighting (k)

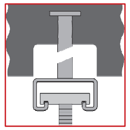
3.3 Overview of necessary verifications for anchor channels



The flow chart depicts the necessary verifications for an anchor channel according to the design model given in CEN 1992-4-3. Both load directions have to be verified separately. The verification paths for shear and tension take all materials involved into account. In case of supplementary reinforcement for higher load resistance this needs to be designed and verified according to a) CEN design rules or b) the ETA approach. In cases where shear and tension occur, verification of combined shear and tension is mandatory.
Design values for steel failure are given in ETA 11/0006. Verifications for concrete failure and failure of supplementary reinforcement are based on design formulae given in CEN TS 1992-4-3.

3.4 Tension: Design steel resistance; $N_{Rd,s}$

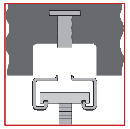
3.4.1 Failure of anchor under consideration



$$N_{Ed}^{a} \le N_{Rd,s,a} = \frac{N_{Rk,s,a}}{\gamma_{Ms}}$$

$N_{Rk,s,a}$; γ_{MS} are given in ETA

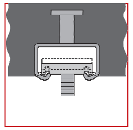
3.4.2 Failure of connection anchor – channel



$$N_{Ed}^{a} \le N_{Rd,s,c} = \frac{N_{Rk,s,c}}{\gamma_{Ms}}$$

$N_{Rk,s,c}$; γ_{MS} are given in ETA

3.4.3 Failure of channel lip



$$N_{Ed} \le N_{Rd,s,l} = \frac{N_{Rk,s,l}}{\gamma_{Ms,l}}$$

$N_{Rk,s,l}$; γ_{MS} are given in ETA

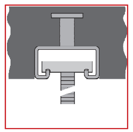
$N_{Rk,s,l}$ has to be reduced if the spacing between neighboring screws is smaller than s_{slb} (specified in ETA, not in CEN) but not smaller than $s_{min,s}$.

s_s… actual spacing between two neighboring screws

s_{slb}… characteristic spacing, depending on channel type, given in ETA

$$N_{Rk,s,l} = 0.5 \cdot \left(1 + \frac{s_s}{s_{slb}}\right) \cdot N_{Rk,s,l} \le 1.0 \cdot N_{Rk,s,c}$$

3.4.4 Failure of special screw

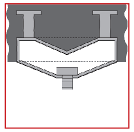


$$N_{Ed} \le N_{Rd,s} = \frac{N_{Rk,s}}{\gamma_{Ms}}$$

$N_{Rk,s}$; γ_{MS} are given in ETA

The characteristic tensile resistance of the special screw is identical with the tensile resistance of standard screws.

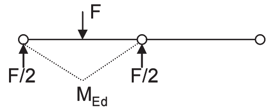
3.4.5 Failure through flexure of channel



$$M_{Ed} \le M_{Rd,sflex} = \frac{M_{Rk,sflex}}{\gamma_{Msflex}}$$

$M_{Rk,s,flex}$; $\gamma_{MS,flex}$ are given in ETA

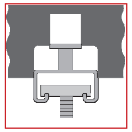
Note: M_{ed} is calculated on a single-span beam w/o constraints.



3.5 Tension: Design concrete resistance $N_{Rd,cx}$

Verifications for concrete failure modes under tension are comprehensive. Each failure mode has its own characteristic resistance to which several factors are applied by multiplication. These factors depend on various given conditions: edges, corners, member thickness, condition of concrete, neighboring anchors or channels, existing reinforcement, supplementary reinforcement.

3.5.1 Pull-out failure



$$N_{Ed}^{a} \le N_{Rd,p} = \frac{N_{Rk,p}}{\gamma_{Mp}}$$

$N_{Rk,p}$; γ_{Mp} are given in ETA

The characteristic resistance $N_{Rk,p}$ is limited by the concrete pressure under the head of the anchor.

$$N_{Rkp} = 6 \cdot A_h \cdot f_{ck,cube} \cdot \psi_{ucrN}$$

A_h load bearing area of the head of the anchor $= \frac{\pi}{4}\left(d_h^2 - d^2\right)$ in case of a round head

$f_{ck,cube}$ characteristic cube strength of concrete

$\psi_{ucr,N}$ = 1.0, for cracked concrete

= 1.4, for non-cracked concrete

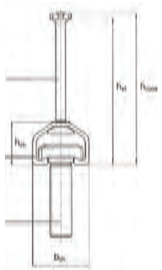
$$N^0_{Rk,c} = 8.5 \cdot \alpha_{ch} \cdot \sqrt{f_{ck,cube}} \cdot h_{ef}^{1.5}$$

$N^0_{Rk,c}$ … basic characteristic resistance of an anchor

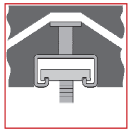
α_{ch} … influence of channel on concrete cone failure, given in ETA

$f_{ck,cube}$ …characteristic cube strength of concrete [N/mm²]

h_{ef} … anchorage depth [mm], given in ETA



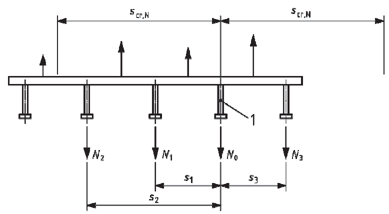
3.5.2 Concrete cone failure



$$N^a_{Ed} \leq N_{Rd,c} = \frac{N_{Rk,c}}{\gamma_{Mc}}$$

$$N_{Rk,c} = N^0_{Rk,c} \cdot \alpha_{s,N} \cdot \alpha_{e,N} \cdot \alpha_{c,N} \cdot \psi_{re,N} \cdot \psi_{ucr,N}$$

3.5.2.1 Effect of neighboring anchors



$$\alpha_{s,N} = \frac{1}{1+\sum_{i=1}^{n}\left[\left(1-\frac{s_i}{s_{cr,N}}\right)^{1.5} \cdot \frac{N_i}{N_0}\right]}$$

$\alpha_{s,N}$ … effect of neighboring anchors

s_i … distance between anchor under consideration and the neighboring anchors

$s_{cr,N}$ …characteristic spacing distance, given in ETA

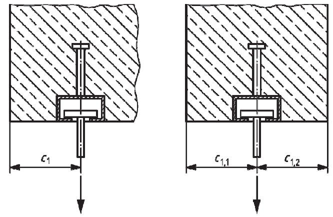
N_i … tensile force of an influencing anchor

N_0 … tensile force of the anchor under consideration

n … number of anchors within a distance $s_{cr,N}$ to both sides of the anchor under consideration

Note: “Anchor under consideration” designates the anchor that we are looking at. We investigate the influence of the anchors i=1,2,… within the characteristic spacing on this anchor.

3.5.2.2 Effect of edges of the concrete member



$$\alpha_{e,N} = \left(\frac{c_1}{c_{cr,N}}\right)^{0.5} \leq 1.0$$

$\alpha_{e,N}$ …effect of edges of the concrete member on the capacity of an anchor

c_1 edge distance of the anchor channel

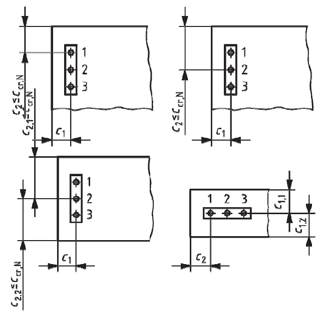
$c_{cr,N}$ characteristic edge distance, given in ETA

Numerical simulation and testing have proven that in case of 2 edges the minimum value governs the capacity. For that reason only the minimum value of $c_{1,2}$ and $c_{2,2}$ has to be considered.

Note: Check that both $c_{1,1}$ and $c_{1,2}$ are greater or equal c_{min} provided by ETA

Edges which are smaller than the characteristic edge distance, $c_1<c_{cr,N}$ have an influence on the design resistance of the concrete. The concrete cone does not develop entirely. Hence, a smaller concrete surface subjected to tensile stresses is activated yielding a smaller resistance against concrete cone break-out. Influenced by the angle of the crack surface the characteristic edge distance is at least 1.5 times the effective embedment depth. The characteristic edge distance is half of the characteristic anchor spacing. In the ETA the minimum values for c_1 (edge) and c_2 (corner) are identical: c_1 = c_2 = c_{min}. Note: c_1 and c_2 refer to the axis of the anchor and NOT to the outside dimension of the channel.

3.5.2.3 Effect of a corner of a concrete member



$$\alpha_{c,N} = \left(\frac{c_2}{c_{cr,N}}\right)^{0.5} \leq 1.0$$

$\alpha_{c,N}$ …effect of a corner of the concrete member on the capacity of an anchor

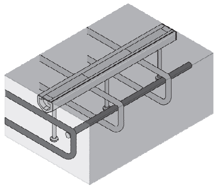
c_2 … corner distance of the anchor under consideration

In contrast to edges, in situations where 2 corners are present the product of both corners has to be considered:

$$\alpha_{c,N} = \left(\frac{c_{2,1}}{c_{cr,N}}\right)^{0.5} \cdot \left(\frac{c_{2,2}}{c_{cr,N}}\right)^{0.5} \leq 1.0$$

Note: Check that both $c_{2,1}$ and $c_{2,2}$ are greater or equal to the minimum value c_{min} provided by ETA

3.5.2.4 Effect of shell spalling



$\psi_{re,N}$ … effect of shell spalling

Tensile stresses in concrete caused by existing reinforcement are superimposed by stresses resulting from the anchor channel thus reducing the capacity.

$$\psi_{re,N} = 0.5 + \frac{h_{ef}}{200} \leq 1.0$$

3.5.2.5 Effect of condition of concrete

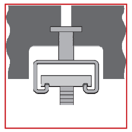
$\psi_{ucr,N}$ = 1.0, for cracked concrete

= 1.4, for non-cracked concrete

Usually RC members are cracked. According to CEN TS 1992-4-1 non-cracked concrete may be assumed if it is proven that under service conditions the fastener with its entire embedment depth is located in non-cracked concrete.

It is always conservative to assume that the concrete is cracked if the concrete condition is unknown.

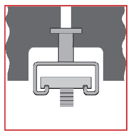
3.5.3 Splitting failure due to installation



This failure mode is avoided if the minimum requirements for edge distance c_{min}, spacing s_{min} and member thickness h_{min} are fulfilled.

c_{min}, s_{min} and h_{min} are given in ETA

3.5.4 Splitting failure due to loading



$$N^a_{Ed} \leq N_{Rd,sp} = \frac{N_{Rk,sp}}{\gamma_{Msp}}$$

$$N_{Rk,sp} = N^0_{Rk} \cdot \alpha_{s,N} \cdot \alpha_{e,N} \cdot \alpha_{c,N} \cdot \psi_{re,N} \cdot \psi_{ucr,N} \cdot \psi_{h,sp}$$

N^0_{Rk} … min ($N_{Rk,p}$; $N^0_{Rk,c}$)

$\alpha_{s,N}$ … effect of neighboring anchors

$\alpha_{e,N}$ … effect of edges of the concrete member

$\alpha_{c,N}$ … effect of a corner of the concrete member

$\psi_{re,N}$ … effect of shell spalling

$\psi_{ucr,N}$… effect for concrete conditions

$\psi_{h,sp}$ … effect of member depth h

3.5.4.1 Effect of neighboring anchors

$\alpha_{s,N}$ …effect of neighboring anchors, value is identical with $\alpha_{s,N}$ for concrete cone break-out (3.5.2.1).

3.5.4.2 Effect of edges of the concrete member

$\alpha_{e,N}$ …effect of edges of the concrete member, value is identical with $\alpha_{e,N}$ for concrete cone break-out (3.6.2.2).

3.5.4.3 Effect of a corner of a concrete member

$\alpha_{e,N}$ …effect of a corner of the concrete member, value is identical with (3.6.2.3)

3.5.4.4 Effect of shell spalling

$\psi_{re,N}$ …effect of shell spalling, value is identical with (3.6.2.4).

$\psi_{ucr,N}$ = 1.0, for cracked concrete

= 1.4, for non-cracked concrete

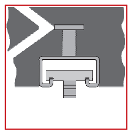
3.5.4.5 Effect of member depth h

$$\psi_{h,sp} = \left(\frac{h}{h_{min}}\right)^{2/3} \leq \left(\frac{2h_{ef}}{h_{min}}\right)^{2/3}$$

$\psi_{h,sp}$ … effect of member depth h

Longitudinal reinforcement should be provided along the edge of the member, if the edge distance is smaller than the value $c_{cr,sp}$.

3.5.5 Blow-out failure



Verification of blow-out is not needed if $c > 0.5h_{ef}$. This requirement is fulfilled for all HAC anchor channels.

Note: The channel requires full constraint!

No lever arm can be assumed if:

a) The fixture is made of metal and in the area of the fastening is fixed directly to the concrete without an intermediate layer or with a leveling layer of mortar with a compressive strength ≥ 30 N/mm² and a thickness ≤ d/2

b) The fixture is in contact with the fastener over a length of at least $0{,}5 \cdot t_{fix}$.

c) The diameter d_f of the hole in the fixture is limited.

With anchor channels, full constraint can be considered only if the special screw is fastened directly to the channel by a separate nut.. If this is not the case, stand-off shear transfer is not permissible.

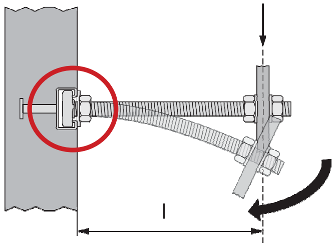
The provisions applicable to stand-off fixtures with anchor channels are similar to those for anchors.

$V_{Rk,s}$; γ_{MS} are given in the relevant ETA

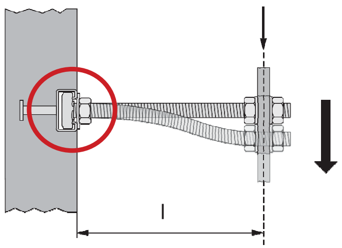
3.6 Shear: Design steel resistance $V_{Rd,s,x}$

3.6.1 Stand-off situation

Length of the lever arm l:

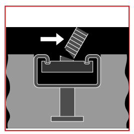


α=1; fixture can rotate



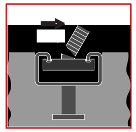
α=2; fixture cannot rotate

3.6.2 Failure of special screw without lever arm



$$V_{Ed} \le V_{Rd,s} = \frac{V_{Rk,s}}{\gamma_{Ms}}$$

3.6.3 Failure of special screw with lever arm



$$V_{Ed} \le V_{Rd,s} = \frac{V_{Rk,s}}{\gamma_{Ms}}$$

$V_{Rk,s}$; γ_{MS} are given in the relevant ETA

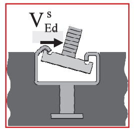
$$V_{Rk,s} = \frac{\alpha_M \cdot M_{Rk,s}}{l}$$

$M^0_{Rk,s}$ … characteristic bending resistance of special screw given in ETA

α_M… degree of restraint of anchor channel

l lever arm

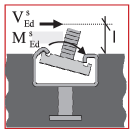
3.6.4 Failure of local flexure of channel lip without lever arm



$$V_{Ed} \le V_{Rd,s,l} = \frac{V_{Rk,s,l}}{\gamma_{Ms,l}}$$

$V_{Rk,s,l}$; $\gamma_{MS,l}$ are given in ETA

3.6.5 Failure of local flexure of channel lip with lever arm



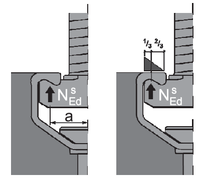
$$N^s_{Ed} \le 0.5 N_{Rd,s,l} = \frac{0.5 \cdot N_{Rk,s,l}}{\gamma_{Ms,l}}$$

$N_{Rk,s}$; γ_{MS} are given in ETA

$$N^s_{Ed} = \frac{M^s_{Ed}}{2 \cdot a}$$

a … distance between screw axis and resultant force

$$M^s_{Ed} = \frac{l \cdot V^s_{Ed}}{\alpha_M}$$



l … lever arm

α_M… degree of restraint of anchor channel

Shear loads with a lever arm first require a translation of the resulting moment into a tensile load acting on the channel lip. Having translated the moment into a corresponding tensile force acting on the channel lip, verification of the channel lip is similar to verifications under pure tensile loads – the only difference is that only one lip is loaded in tension and therefore the given design resistance (ETA) of the channel lip under tension is reduced by 50%.

γ_{Mc} given in ETA

$$V_{Rk,cp} = k_5 \cdot N_{Rk,c}$$

$N_{Rk,c}$: according to the verification of concrete cone failure under tensile load, determined for the anchors loaded in shear

k_5… given in ETA, (Hilti HAC anchor channel: k_5=2.0) in case of additional shear reinforcement: k_5*0.75

Pry-out is a failure mode where concrete break-out occurs due to shear loading at the back of the channel. As the concrete cone looks similar to the concrete cone that occurs under tensile loads, the resistant pry-out load is based on the resistance of concrete cone break-out under tensile load multiplied by the factor k_5.

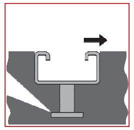
$\alpha_{s,V}$ … effect of neighboring anchors
$\alpha_{c,V}$ … effect of a corner of the concrete member
$\alpha_{h,V}$ … effect of thickness of concrete member
$\alpha_{90°,V}$ … effect of load parallel to the edge
$\psi_{re,V}$ … effect of concrete conditions

$$V^0_{Rk,c} = \alpha_p \cdot \sqrt{f_{ck,cube}} \cdot c_1^{1.5}$$

α_p … given in ETA
$f_{ck,cube}$ characteristic cube strength of concrete [N/mm²]
c_1 … edge distance [mm]

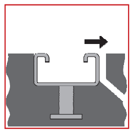
3.7 Shear: Design concrete resistance $V_{Rd,c}$

3.7.1 Pry-out failure



$$V^a_{Ed} \le V_{Rd,cp} = \frac{V_{Rk,cp}}{\gamma_{Mc}}$$

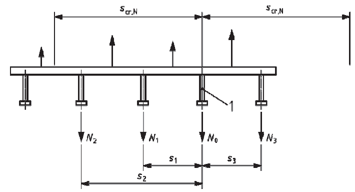
3.7.2 Concrete edge failure



$$V^a_{Ed} \le V_{Rd,c} = \frac{V_{Rk,c}}{\gamma_{Mc}}$$

$$V_{Rk,c} = V^0_{Rk,c} \cdot \alpha_{s,V} \cdot \alpha_{c,V} \cdot \alpha_{h,V} \cdot \alpha_{90°,V} \cdot \Psi_{re,V}$$

3.7.2.1 Effect of neighboring anchors

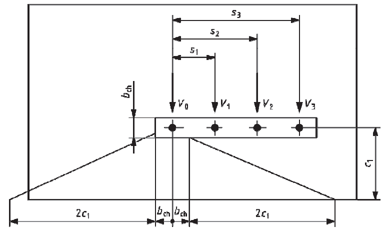


$$\alpha_{s,V} = \frac{1}{1 + \sum_{i=1}^{n} \left[\left(1 - \frac{s_i}{s_{cr,V}}\right)^{1.5} \cdot \frac{V_i}{V_0} \right]}$$

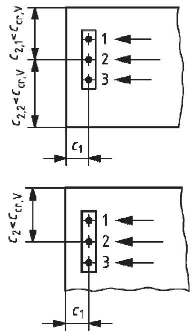
s_i … distance between anchor under consideration and the neighboring anchors
$s_{cr,V}$ characteristic spacing distance
V_i … shear force of an influencing anchor
V_0 … shear force of the considered anchor
n … number of anchors within a distance $s_{cr,V}$ to both sides of the considered anchor
b_{ch}… width of anchor channel

$$s_{cr,V} = 4c_1 + 2b_{ch}$$

Overlapping breakout cones of anchors lead to a reduction of the capacity. The factor $\alpha_{s,V}$ accounts for the mutual effect of the anchors loaded in shear.



3.7.2.2 Effect of corner of the concrete member



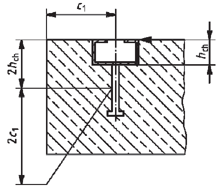
$$\alpha_{c,V} = \left(\frac{c_2}{c_{cr,V}}\right)^{0.5} \le 1.0$$

$\alpha_{c,V}$ … effect of corners of the concrete member
c_2 … corner distance of the anchor channel
$c_{cr,V}$… characteristic edge distance, given in ETA

$$c_{cr,V} = 0.5 s_{cr,V} = 2c_1 + b_{ch}$$

For anchors influenced by two corners (c_2<$c_{cr,V}$) the factor $\alpha_{c,V}$ should be calculated for each corner and the product of the factors $\alpha_{c,V}$ should be inserted.

3.7.2.3 Effect of thickness of structural component

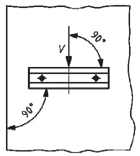


h_{ch} … height of anchor channel
c_1… edge distance

$h_{cr,V} = 2c_1 + h_{ch}$

$$\alpha_{h,V} = \left(\frac{h}{h_{cr,V}}\right)^{0.5} \leq 1.0$$

3.7.2.4 Effect of load parallel to the edge

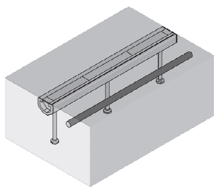


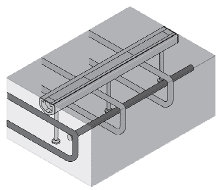
$$\alpha_{90°,V} = 2.5$$

in all other cases $\alpha_{90°,V} = 1$

Engineering judgment is needed in case the angle α slightly deviates from 90°.

3.7.2.5 Effect of anchor channel position





For Hilti channels ($h_{ch} \leq 40$mm):

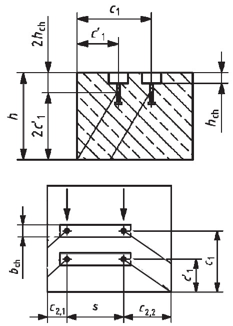
$\psi_{re,V} = 1.0$ anchor channel in cracked concrete without edge reinforcement or stirrups

$\psi_{re,V} = 1.2$ anchor channel in cracked concrete with straight edge reinforcement (≥ ø 12mm)

$\psi_{re,V} = 1.4$ anchor channel in cracked concrete with edge reinforcement and stirrups with a spacing $a \leq 100$mm and $a \leq 2c_1$

$\psi_{re,V} = 1.4$ non-cracked concrete

3.7.2.6 Effect of narrow thin member



A narrow thin member can be assumed if $c_{2,max} \leq c_{cr,V}$ and $h \leq h_{cr,V}$. More realistic results may be obtained by using a virtual edge distance c'_1 instead of c_1:

$$c'_1 = \max \begin{cases} (\max(c_{2,1};c_{2,2}) - b_{ch})/2 \\ (h - 2h_{ch})/2 \end{cases}$$

$c_{2,max}$ … largest of the two edge distances parallel to the direction of load

3.8 Combined tension and shear loading

3.8.1 Anchor channels without supplementary reinforcement

$$\beta_N^2 + \beta_V^2 \le 1 \qquad (1)$$

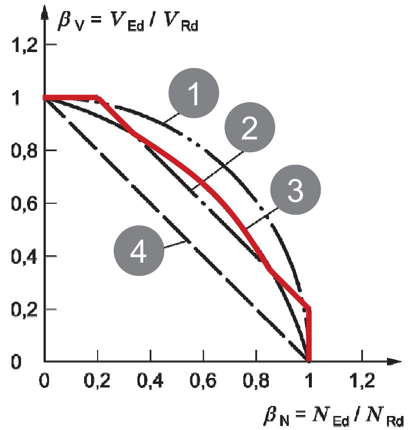
with

$$\beta_N = N_{Ed}/N_{Rd} \le 1$$
$$\beta_V = V_{Ed}/V_{Rd} \le 1$$

$$\beta_N + \beta_V \le 1.2 \qquad (2)$$
$$\beta_N^{1.5} + \beta_V^{1.5} \le 1 \qquad (3)$$

with

$$\beta_N = N_{Ed}/N_{Rd} \le 1$$
$$\beta_V = V_{Ed}/V_{Rd} \le 1$$



(1) Steel failure for tension and shear

(2),(3) Other failure modes for tension and shear

(4) Supplementary reinforcement to bear shear forces and anchor channels close to the edge

3.8.2 Anchor channels with supplementary reinforcement

$$\beta_N + \beta_V \le 1 \qquad (4)$$

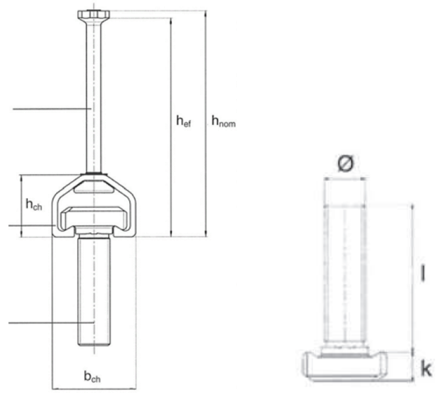
with

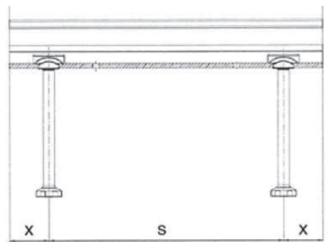
$$\beta_N = N_{Ed}/N_{Rd} \le 1$$
$$\beta_V = V_{Ed}/V_{Rd} \le 1$$

Quadratic interaction can be used (formula for circles with the power of 2 (graph 1)) only in cases where steel failure occurs under both tension and shear. Where other failure modes or a combination of steel and concrete failure occur, either tri-linear superposition (graph 2) or a parabola with the power of 1.5 can be applied. Linear interpolation has to be chosen (graph 4) only in cases where supplementary reinforcement takes up shear loads and the channel is placed closed to the concrete edge.

4 Technical data for the HAC anchor channel system

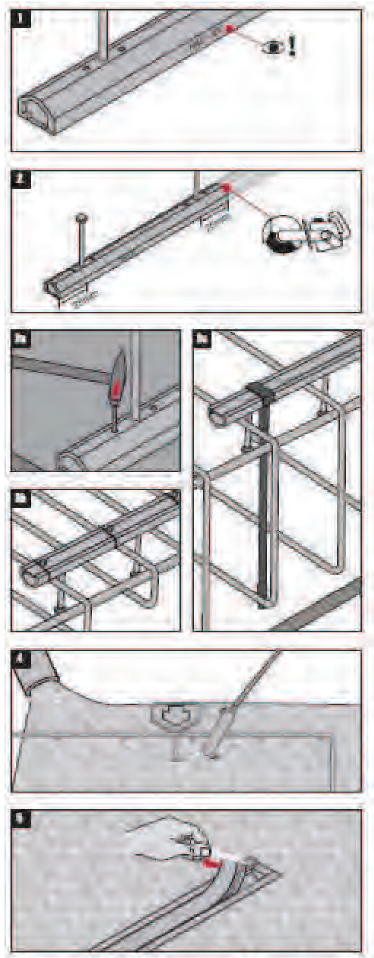
4.1 General



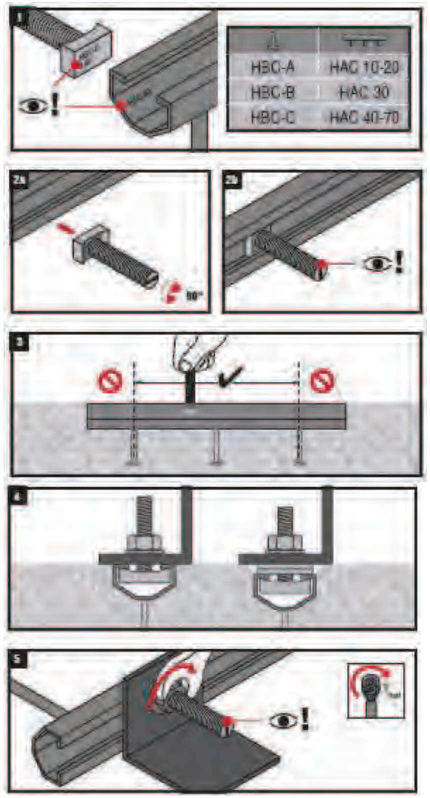


4.2 Instruction for use

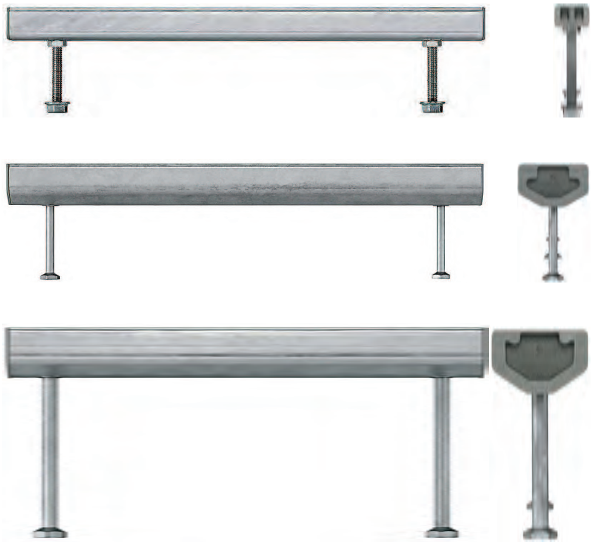
4.2.1 HAC



4.2.2 HBC



4.3 HAC Hilti Anchor Channel



Anchor channel	Dimensions							
	b_{ch}	h_{ch}	s_{min}	s_{max}	End spacing	min channel length	h_{ef}	c_{min}
	[mm]							
HAC-10	26.2	16.7	50	200	25	100	45	40
HAC-20	27.5	18.0	50	200	25	100	76	50
HAC-30	41.3	25.6	50	250	25	100	68	50
HAC-40	40.9	28.0	100	250	25	150	91	50
HAC-50	41.9	31.0	100	250	25	150	106	75
HAC-60	43.4	35.5	100	250	25	150	148	100
HAC-70	45.4	40.0	100	250	25	150	167	100

4.4 HBC special screws

Dimensions of special screws

Anchor channel	Special screw type	Dimensions		
		Ø	Length	t_{fix}
		[mm]		
HAC-10 HAC-20	HBC-A	8	15-100	1 – 26
		10	15-175	3 – 83.5
		12	20-200	10 – 130
HAC-30	HBC-B	8	15-150	11 – 81
		10	15-175	18 – 78
		12	20-200	15 – 125
HAC-40 HAC-50 HAC-60 HAC-70	HBC-C	10	20-200	8 – 78
		12	20-200	5 – 100
		16	20-300	1 – 120
		20	20-300	15 – 115
HAC-40 HAC-50	HBC-C-E	12	20-200	17 – 127
		16	20-300	23 – 263
HAC-40 HAC-50 HAC-60 HAC-70	HBC-C-N	16	20-200	20 – 30
		20	20-300	25 – 65

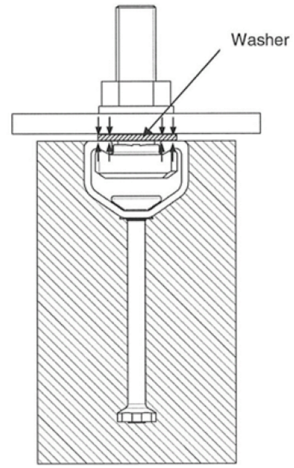
4.5 Material properties

Part	Material	
Channel profile	Carbon steel:	EN 10149-2; EN 10051 hot-dip galv. ≥ 55 µm [2] (HAC-10 and HAC-20)
	Carbon steel:	EN 10025-2 hot-dip galv. ≥ 55 µm [2] (HAC-30 to HAC-50)
	Carbon steel:	EN 10025-2 hot-dip galv. ≥ 70 µm [2] (HAC-60 and HAC-70)
Rivet	Carbon steel:	hot-dip galv. ≥ 45 µm [3]
Anchor	Carbon steel:	hot-dip galv. ≥ 45 µm [3]
HILTI special screw shaft and thread according to EN ISO 4018	Carbon steel:	steel grade 4.6 / 8.8 in dependence on electroplated ≥ 8 µm [1]
	Carbon steel:	steel grade 4.6 / 8.8 in dependence on EN ISO 898-1 [4] hot-dip galv. ≥ 45 µm [3])
	Stainless steel: steel grade 50	1.4401/ 1.4404/ 1.4571/ 1.4362/ 1.4578/ 1.4439 EN ISO 3506-1 / EN10088-2
Washer EN ISO 7089 and EN ISO 7093-1 production class A, 200 HV	Carbon steel:	EN 10025-2 electroplated ≥ 5 µm [1]
	Carbon steel:	EN 10025-2 hot-dip galv. > 45 µm [3]
	Stainless steel: 1.4401/ 1.4404/ 1.4571/ 1.4362/ 1.4578/ 1.4439	EN 10088
Hexagonal nuts DIN 934 [5] EN ISO 4032	Carbon steel:	class 5 / 8; EN 20898-2 electroplated ≥ 8 µm [1]
	Carbon steel: class 5 / 8; EN 20898-2	hot-dip galv. ≥ 45 µm [3]
	Stainless steel: class 70	1.4401/ 1.4404/ 1.4571/ 1.4362/ 1.4578/ 1.4439 EN ISO 3506-2 / EN 10088-2

[1] Electroplated according to EN ISO 4042, A3K
[2] Hot-dip galv. according to EN ISO 1461:2009-10 (Mean coating thickness (minimum))
[3] Hot-dip galv. according to ISO 1461:1999 (Mean coating thickness (minimum))
[4] Properties according to EN ISO 898-1 only in threaded part of screw
[5] DIN 934 only for special screw grade 4.6 and stainless steel

4.6 Setting torque T_{inst} for HAC-10 through HAC-30

	Special screw	Ø	Min. spacing	Setting torque T_{inst}		
				general	Steel – steel contact	
				4.6; 8.8; A4-50	4.6; A4-50	8.8
			[mm]	[Nm]		
HAC-10	HBC-A	8	40	6	8	20
		10	50	6	15	48
		12	60	6	25	70
HAC-20		8	40	8	8	20
		10	50	15	15	48
		12	60	20	25	70
HAC-30	HBC-B	8	40	8	8	20
		10	50	15	15	48
		12	60	25	25	70



4.7 Tightening torque T_{inst} for HAC-40 through HAC-70

Anchor channel	Special screw type	Ø	Min. spacing screw s_{min}	Tightening torque T_{inst} general	Tightening torque T_{inst} Steel – steel contact	
				4.6; 8.8; A4-50	4.6; A4-50	8.8
			[mm]	[Nm]		
HAC-40	HBC-C HBC-C-E HBC-C-N	10	50	15	15	48
		12	60	25	25	70
		16	80	60	60	200
		20	100	75	120	400
HAC-50		10	50	15	15	48
		12	60	25	25	70
		16	80	60	60	200
		20	100	120	120	400
HAC-60		10	50	15	15	48
		12	60	25	25	70
		16	80	60	60	200
		20	100	120	120	400
HAC-70		10	50	15	15	48
		12	60	25	25	70
		16	80	60	60	200
		20	100	120	120	400

4.8 Characteristic resistance for steel failure of the channel

	Data according ETA-11/0006, issue 2011-02-08						
Anchor channel	HAC-10	HAC-20	HAC-30	HAC-40	HAC-50	HAC-60	HAC-70
Tensile, anchor, $N_{Rk,s,a}$ [kN]	13	32	20	33	36	58	83
γ_{Ms}	1.8						
Tensile, connection channel anchor $N_{Rk,s,c}$ [kN]	9	18	18	25	33	52	73
$\gamma_{Ms,ca}$	1.8						
Tensile, local flexure of channel lip $N_{Rk,s,l}$ [kN]	9	18	18	25	33	52	73
$\gamma_{Ms,l}$	1.8						
Flexure, resistance of channel $M_{Rk,s,flex}$ [Nm]	292	584	708	944	1364	2077	3239
$\gamma_{Ms,flex}$	1.15						
Shear, local flexure of channel lip $V_{Rk,s,l}$ [kN]	12	18	19	35	51	67	79
$\gamma_{Ms,l}$	1.8						

4.9 Characteristic resistance for steel failure of special screw type HBC-A, HBC-B, HBC-C, HBC-C-E, HBC-C-N

			Data according ETA-11/0006, issue 2011-02-08				
Special screw Ø			M8	M10	M12	M16	M20
Tensile, $N_{Rk,s}$ [kN]	HBC-A	4.6	14.6	23.2	33.7	-	-
		A4-50	18.3	29.0	42.2	-	-
	HBC-B	4.6	14.6	23.2	33.7	-	-
		A4-50	18.3	29.0	42.2	-	-
	HBC-C HBC-C-E HBC-C-N	4.6	-	23.2	33.7	62.8	98.0
		8.8	-	46.4	67.4	125.6	196.0
		A4-50	-	29.0	42.2	78.5	122.5
γ_{Ms}		4.6	2.00				
		8.8	1.50				
		A4-50	2.86				
Shear $V_{Rk,s}$ [kN]	HBC-A	4.6	7.3	11.6	16.8	-	-
		A4-50	9.2	14.5	21.1	-	-
	HBC-B	4.6	7.3	11.6	20.2	-	-
		A4-50	9.2	14.5	24.0	-	-
	HBC-C HBC-C-E HBC-C-N	4.6	-	13.9	20.2	37.6	58.8
		8.8	-	23.2	33.7	62.7	97.9
		A4-50	-	17.4	25.3	47.0	73.4
γ_{Ms}		4.6	1.67				
		8.8	1.25				
		A4-50	2.38				
Flexure $M^0_{Rk,s}$ [Nm]	HBC-A	4.6	15.0	29.9	52.4	-	-
		A4-50	18.7	37.4	65.5	-	-
	HBC-B	4.6	15.0	29.9	52.4	-	-
		A4-50	18.7	37.4	65.5	-	-
	HBC-C HBC-C-E HBC-C-N	4.6	-	29.9	52.4	133.2	259.6
		8.8	-	598	104.8	266.4	519.3
		A4-50	-	37.4	65.5	166.5	324.5
γ_{Ms}		4.6	1.67				
		8.8	1.25				
		A4-50	2.38				

4.10 Design tensile pull-out failure

$$N_{Rd,p} = \frac{N_{Rk,p}}{\gamma_{Mp}} \cdot \psi_c \cdot \psi_{ucr,N}$$

Anchor channel			Data according ETA-11/0006, issue 2011-02-08						
			HAC-10	HAC-20	HAC-30	HAC-40	HAC-50	HAC-60	HAC-70
Characteristic resistance, $N_{Rk,p}$ for C20/25 [kN]			8.4	13.9	12.2	15.4	22.2	35.2	48.6
Amplification factor for concrete strength [-]	C12/15	ψ_c	0.60						
	C16/20		0.80						
	C20/25		1.00						
	C25/30		1.20						
	C30/37		1.48						
	C35/45		1.80						
	C40/50		1.99						
	C45/55		2.20						
	≥C50/60		2.40						
Factor for uncracked concrete [-]		$\psi_{ucr,N}$	1.4						
$\gamma_{Mp} = \gamma_{Mc}$ 1)			1.5						

1) In absence of other national regulations

4.11 Design tensile concrete cone failure

$$N_{Rd,c} = \frac{N^0_{Rk,c}}{\gamma_{Mc}} \cdot \alpha_{s,N} \cdot \alpha_{e,N} \cdot \alpha_{c,N} \cdot \psi_c \cdot \psi_{re,N} \cdot \psi_{ucr,N}$$

Anchor channel			Data according ETA-11/0006, issue 2011-02-08						
			HAC-10	HAC-20	HAC-30	HAC-40	HAC-50	HAC-60	HAC-70
Characteristic resistance, $N^0_{Rk,c}$ for C20/25 [kN]			10.42	24.75	20.59	33.31	42.86	74.30	90.71
Amplification factor for concrete strength [-]	C12/15	ψ_c	0.77						
	C16/20		0.89						
	C20/25		1.00						
	C25/30		1.10						
	C30/37		1.22						
	C35/45		1.34						
	C40/50		1.41						
	C45/55		1.48						
	≥C50/60		$= (f_{ck,cube} / 25\ N/mm^2)^{1/2}$						
Effect of neighboring anchors [-] 1)		$\alpha_{s,N}$	$\alpha_{sN} = \frac{1}{1+\sum_{i=1}^{n}\left[\left(1-\frac{s_i}{s_{crN}}\right)^{1.5} \cdot \frac{N_i}{N_0}\right]}$						
Characteristic spacing of anchor [mm]		$s_{cr,N}$	222	342	314	390	432	512	532
Effect of edges of the concrete member [-] 1)		$\alpha_{e,N}$	$\alpha_{e,N} = \left(\frac{c_1}{c_{cr,N}}\right)^{0.5} \le 1.0$						
Characteristic edge distance of anchor [mm]		$c_{cr,N}$	111	171	157	195	216	256	266
Effect of corner of the concrete member [-] 1)		α_{cN}	$\alpha_{c,N} = \left(\frac{c_2}{c_{cr,N}}\right)^{0.5} \le 1.0$						
Factor for shell spalling [-]		$\psi_{re,N}$	$=0.5+h_{ef} / 200 \le 1.0$						
Factor for un-cracked concrete [-]		$\psi_{ucr,N}$	1.4						
$\gamma_{Mp} = \gamma_{Mc}$ 1)			1.5						

1) Values depending on influencing loads, anchor channel length, concrete geometry, etc. No pre-calculated values given.

Design tensile splitting failure: c are fulfilled — Verification of splitting due to installation not relevant if min. values for h, s, c are fulfilled

Anchor channel	Data according ETA-11/0006, issue 2011-02-08						
	HAC-10	HAC-20	HAC-30	HAC-40	HAC-50	HAC-60	HAC-70
h_{min} [mm]	60	92.5	80	104	119.5	162.5	190
s_{min} [mm]	50	50	50	100	100	100	100
c_{min} [mm]	40	50	50	50	75	100	100

4.12 Design shear pry out failure

$$V_{Rd,cp} = k_5 \cdot \frac{N_{Rk,c}}{\gamma_{Mc}}$$

		Data according ETA-11/0006, issue 2011-02-08						
Anchor channel		HAC-10	HAC-20	HAC-30	HAC-40	HAC-50	HAC-60	HAC-70
Factor for shear resistance 1)	k_5	2.0						
$\gamma_{Mp} = \gamma_{Mc}$		1.5						

1) Without supplementary reinforcement. In case of supplementary reinforcement the factor k_5 should be multiplied by 0.75

4.13 Design shear concrete edge failure

$$V_{Rd,c} = \frac{V^0_{Rk,c}}{\gamma_{Mc}} \cdot \alpha_{s,V} \cdot \alpha_{c,V} \cdot \alpha_{h,V} \cdot \alpha_{90°,V} \cdot \psi_{re,V} \cdot \psi_c$$

			Data according ETA-11/0006, issue 2011-02-08						
Anchor channel			HAC-10	HAC-20	HAC-30	HAC-40	HAC-50	HAC-60	HAC-70
Characteristic resistance, $V^0_{Rk,c}/\cdot c_1^{1.5}$ for C20/25 [kN]			15.00	20.00	17.50	20.00 1)	20.00 1)	20.00	20.00
Amplification factor for concrete strength [-]	C12/15	ψ_c	0.77						
	C16/20		0.89						
	C20/25		1.00						
	C25/30		1.10						
	C30/37		1.22						
	C35/45		1.34						
	C40/50		1.41						
	C45/55		1.48						
	≥C50/60		$= (f_{ck,cube} / 25\ N/mm^2)^{1/2}$						
Effect for neighboring anchors [-]		$\alpha_{s,V}$	$\alpha_{s,V} = \frac{1}{1+\sum_{i=1}^{n}\left[\left(1-\frac{s_i}{s_{cr,V}}\right)^{1.5} \cdot \frac{V_i}{V_0}\right]}$						
Characteristic spacing of anchor [mm]		$s_{cr,V}$	$4c_1+52.4$	$4c_1+55$	$4c_1+82.6$	$4c_1+81.8$	$4c_1+83.8$	$4c_1+86.8$	$4c_1+90.8$
Effect of corner of the concrete member [-]		$\alpha_{c,V}$	$\alpha_{c,V} = \left(\frac{c_2}{c_{cr,V}}\right)^{0.5} \le 1.0$						
Characteristic edge distance of anchor [mm]		$c_{cr,N}$	$2c_1+26.2$	$2c_1+27.5$	$2c_1+41.3$	$2c_1+40.9$	$2c_1+41.9$	$2c_1+43.4$	$2c_1+45.4$
Effect of thickness of structural component [-]		$\alpha_{h,V}$	$\alpha_{h,V} = \left(\frac{h}{h_{cr,V}}\right)^{2/3} \le 1.0$		$\alpha_{h,V} = \left(\frac{h}{h_{cr,V}}\right)^{1/2} \le 1.0$				
Characteristic edge distance of anchor [mm]		$h_{cr,V}$	$2c_1+16.7$	$2c_1+18.0$	$2c_1+25.6$	$2c_1+28.0$	$2c_1+31.0$	$2c_1+35.5$	$2c_1+40.0$
Effect of load parallel to the edges [-]		$\alpha_{90°,V}$	2.5 2)						
Effect of reinforcement [-]		$\psi_{re,V}$	1.0 anchor channel in cracked concrete without edge reinforcement or stirrups						
			1.2 anchor channel in cracked concrete with straight edge reinforcement (≥ ø 12mm)						
			1.4 anchor channel in cracked concrete with edge reinforcement and stirrups with a spacing a ≤ 100mm and a ≤ $2c_1$ or uncracked concrete						
$\gamma_{Mp} = \gamma_{Mc}$ 1)			1.5						

1) When special screw HBC-C-E is used please use reduced value: 17.50 kN
2) In all other cases 1.0

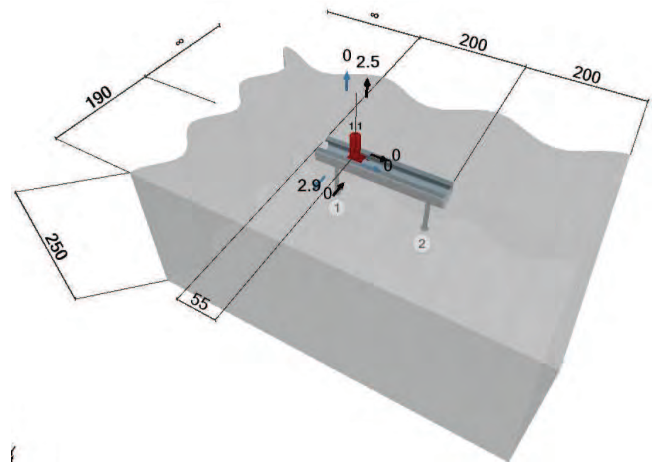
5 Design examples

5.1 Example 1: Anchor channel subjected to tensile and shear load

5.1.1 Anchoring conditions

System, basic values

Anchor channel	HAC-40F, 200 mm (2 anchors)
Hilti special screw	HBC-C-N 8.8F M16 x 50
Concrete	Cracked concrete, C30/37
Stand-off	no
Characteristic tensile dead load	2.5 kN
Characteristic shear live load	2.9 kN
Member thickness h	250 mm
Reinforcement conditions (tension)	ø≥12mm with a spacing of s≥150mm
Reinforcement conditions (shear)	With edge reinforcement ds ≥ 12 mm
Reinforcement conditions (splitting)	Reinforcement for w≤0.3mm present
Effective embedment depth of anchor h_{ef}	91 mm
Width of channel b_{ch}	40.9 mm
Height of channel h_{ch}	28.0 mm
Moment of inertia channel I_y	21452 mm^4
Anchor spacing 200mm s	150 mm



Steel failure TENSION, characteristic values and safety factors

Steel failure, anchor	$N_{Rk,s,a}$	33.0 kN
Steel failure, connection channel anchor	$N_{Rk,s,c}$	25.0 kN
Steel failure, local flexure of channel lips for $s_s \geq s_{slb}$	$N_{Rk,s,l}$	25.0 kN
Characteristic flexure resistance of channel	$M_{Rk,s,flex}$	0.944 kNm

Steel failure Hilti-special screw	$N_{Rk,s,s}$	125.6 kN
Partial safety factor, Hilti-special screw	$\gamma_{Ms,s}$	1.50
Partial safety factor, anchor	γ_{Ms}	1.80
Partial safety factor, connection channel anchor	$\gamma_{Ms,ca}$	1.80
Partial safety factor, local flexure of channel lips	γ_{Ms}=	1.80
Partial safety factor, flexure resistance of channel	$\gamma_{Ms,flex}$	1.15

Steel failure SHEAR, characteristic values and safety factors

Steel failure, local flexure of channel lip	$V_{Rk,s,l}$	35.0 kN
Steel failure, local flexure of channel lip, shear parallel	$V_{Rk,s,l,II}$	5.0 kN
Steel failure Hilti special screw	$V_{Rk,s}$	62.7 kN
Partial safety factor local flexure of channel lip	$\gamma_{Ms,l}$	1.8
Partial safety factor local flexure of channel lip	$\gamma_{Ms,l,II}$	1.8
Partial safety factor Hilti special screw (shear)	$\gamma_{Ms,s}$	1.25

Concrete failure TENSION, characteristic values and safety factors

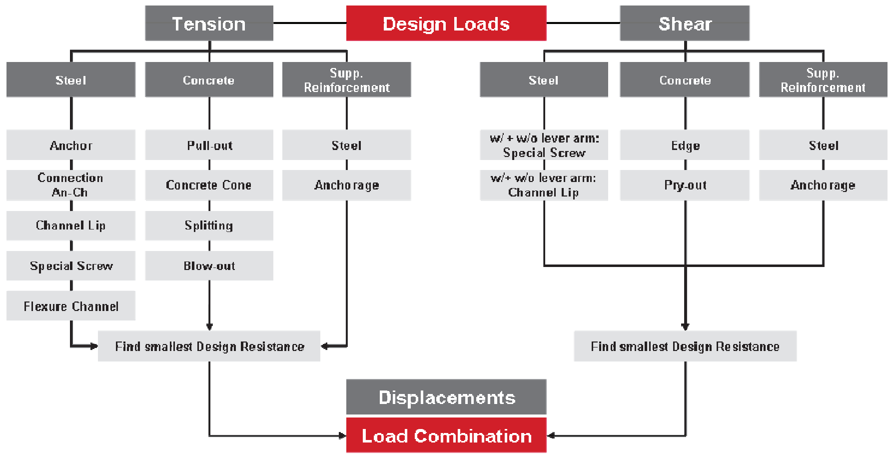
Pull-out failure resistance in cracked concrete C12/15	$N_{Rk,p}$, C12/15	9.2 kN
Effective anchorage depth	h_{ef}	91 mm
Characteristic edge distance	$c_{cr,N}$	195 mm
Characteristic spacing	$s_{cr,N}$	390 mm
Amplification factor of $N_{Rk,p}$ for C30/37	ψ_c	2.47
Factor for anchor channel influencing concrete cone	α_{ch}	0.903
Partial safety factor concrete	γ_{Mc}	1.5
Partial safety factor for pull-out	$\gamma_{Mc,p}$	1.5

Concrete failure SHEAR, characteristic values and safety factors

Factor k in equation (31) of CEN/TS 1992-4-3	k_5	2.0
Product of factor αp and $\psi_{re,V}$	$\alpha_p\ \psi_{re,V}$	4.8
Effect of thickness of structural component = $(h/h_{cr,V})1/2$	$\alpha_{h,V}$	0.757
Characteristic height = $2(c_1 + h_{ch})$	$h_{cr,V}$	436 mm
Characteristic edge distance = $2c_1 + b_{ch}$	$c_{cr,V}$	421 mm
Characteristic spacing = $4_{c1} + 2b_{ch}$	$s_{cr,V}$	842 mm
Partial safety factor concrete	γ_{Mc}	1.5

General remarks

According to CEN 1994-4-3 the following verifications have to be done:



The verifications are calculated with the directly acting load and with the distributed anchor load, respectively. For this reason, the distributed loads acting on the anchor have to be calculated first. Please note that these loads heavily depend on the load position of the acting external load. In other words, the verification is only valid for the given load position of the screw.

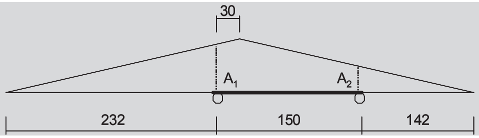
5.1.2 Determination of acting forces

Direct forces acting on screw

Design tensile load	$N_{Ed} = \gamma \cdot F_{z,G}$	$N_{Ed} = 1.35 \cdot 2.5 = 3.38kN$
Design shear load	$V_{Ed} = \gamma \cdot F_{y,Q}$	$V_{Ed} = 1.5 \cdot (-2.9) = -4.35kN$
Influence length	$l_i = 13 \cdot l_y^{0.05} \cdot s^{0.5} \geq s$	$l_i = 13 \cdot 21452^{0.05} \cdot \sqrt{150} = 262mm \geq s$

Forces acting on anchors

Load distribution scheme based on influence length l_i



Calculate A_i on basis of theorem of intersecting lines

$$A_1 = \frac{262-30}{262} = 0.885 \qquad A_2 = \frac{262-150+30}{262} = 0.542$$

Weighting factor

$$k = \frac{1}{\sum_1^n A_i^{'}} \qquad k = \frac{1}{0.885+0.542} = 0.70$$

Tensile force anchor 1	$N^a_{Ed,1} = k \cdot A_1^{'} \cdot N_{Ed}$	$N^a_{Ed,1} = 0.7 \cdot 0.885 \cdot 3.375kN = 2.09\ kN$
Tensile force anchor 2	$N^a_{Ed,2} = k \cdot A_2^{'} \cdot N_{Ed}$	$N^a_{Ed,2} = 0.7 \cdot 0.542 \cdot 3.375kN = 1.28\ kN$
Shear force anchor 1	$V^a_{Ed,1} = k \cdot A_1^{'} \cdot V_{Ed}$	$V^a_{Ed,1} = 0.7 \cdot 0.885 \cdot 4.35kN = 2.69\ kN$
Shear force anchor 2	$V^a_{Ed,2} = k \cdot A_2^{'} \cdot V_{Ed}$	$V^a_{Ed,2} = 0.7 \cdot 0.542 \cdot 4.35kN = 1.65\ kN$

5.1.3 Tensile loading

Design steel resistance anchor

$$N_{Rd,s,a} = \frac{N_{Rk,s,a}}{\gamma_{Ms}} \qquad N_{Rd,s,a} = \frac{33.0kN}{1.8} = 18.3kN$$

Design steel resistance connection anchor - channel

$$N_{Rd,s,c} = \frac{N_{Rk,s,c}}{\gamma_{Ms,ca}} \qquad N_{Rd,s,c} = \frac{25.0kN}{1.8} = 13.9kN$$

Design steel resistance local flexure of channel lip

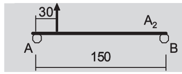
$$N_{Rd,s,l} = \frac{N_{Rk,s,l}}{\gamma_{Ms,l}} \qquad N_{Rd,s,l} = \frac{25.0kN}{1.8} = 13.9kN$$

Design steel resistance special screw

$$N_{Rd,s,s} = \frac{N_{R,k,s,s}}{\gamma_{Ms,s}} \qquad N_{Rd,s,l} = \frac{125.6kN}{1.50} = 83.7kN$$

Design steel resistance flexure of channel

Determination of acting moment based on single supported beam



$$A = \frac{120}{150} \cdot 3.375kN = 2.7kN$$

$$M_{Ed} = 2.7kN \cdot 0.03m = 0.081kNm$$

$$M_{Rd,s,flex} = \frac{M_{Rk,s,flex}}{\gamma_{Ms,flex}} \qquad M_{Rd,s,flex} = \frac{944Nm}{1.15} = 0.821kNm$$

Design concrete pull-out resistance

Cracked concrete pull-out resistance

$$N_{Rd,p} = \frac{N_{Rk,p}}{\gamma_{Mc,p}} \cdot \psi_c \cdot \psi_{ucr} \qquad N_{Rd,p} = \frac{N_{Rk,p}}{\gamma_{Mc,p}} \cdot \psi_c \cdot \psi_{ucr} = 15.1kN$$

Design concrete cone resistance

Basic resistance

$$N^0_{Rk,c} = 8.5 \cdot \alpha_{ch} \cdot \sqrt{f_{ck,cube}} \cdot h_{ef}^{1.5} \qquad N^0_{Rk,c} = 8.5 \cdot 0.903 \cdot \sqrt{37} \cdot 91^{1.5} = 40.5kN$$

Effect of neighboring anchors, anchor 1

$$\alpha_{s,N} = \frac{1}{1+\sum_{i=1}^{n}\left[\left(1-\frac{s_i}{s_{cr,N}}\right)^{1.5} \cdot \frac{N_i}{N_0}\right]} \qquad \alpha^1_{s,N} = \frac{1}{1+\sum_{i=1}^{1}\left[\left(1-\frac{150}{390}\right)^{1.5} \cdot \frac{1.28}{2.09}\right]} = 0.772$$

Effect of neighboring anchors, anchor 2

$$\alpha^2_{s,N} = \frac{1}{1+\sum_{i=1}^{1}\left[\left(1-\frac{150}{390}\right)^{1.5} \cdot \frac{2.09}{1.28}\right]} = 0.560$$

Effect of edges	$\alpha_{e,N} = \left(\frac{c_1}{c_{cr,N}}\right)^{0.5} \le 1.0$	$\alpha_{e,N} = \left(\frac{190}{195}\right)^{0.5} = 0.987$
Effect of corner 1	$\alpha_{c,N} = \left(\frac{c_2}{c_{cr,N}}\right)^{0.5} \le 1.0$	$\alpha^1_{c,N} = \left(\frac{\infty}{195}\right)^{0.5} = \infty > 1.0$
Effect of corner 2		$\alpha^2_{c,N} = \left(\frac{225}{195}\right)^{0.5} = 1.07 > 1.0$
Effect of shell spalling	$\psi_{re,N} = 0.5 + \frac{h_{ef}}{200} \le 1.0$	$\Psi_{re,N} = 1.0$ may be taken if local to this anchor channel reinforcement (any diameter) is provided at a spacing ≥ 150 mm
Effect of concrete conditions		$\Psi_{ucr,N} = 1.0$
Characteristic resistance	$N_{Rk,c} = N^0_{Rk,c} \cdot \alpha_{s,N} \cdot \alpha_{e,N} \cdot \alpha_{c,N} \cdot \psi_{re,N} \cdot \psi_{ucr,N}$ Anchor 1: $N^1_{Rk,c} = 40.5 \cdot 0.772 \cdot 0.987 \cdot 1.0 \cdot 1.0 \cdot 1.0 = 30.9kN$ Anchor 2: $N^2_{Rk,c} = 40.5 \cdot 0.560 \cdot 0.987 \cdot 1.0 \cdot 1.0 \cdot 1.0 = 22.4kN$	
Design resistance	Anchor 1: $N_{Rd,c} = \frac{N_{Rk,c}}{\gamma_{Mc}} = 20.6kN$ Anchor 2: $N_{Rd,c} = \frac{N_{Rk,c}}{\gamma_{Mc}} = 14.9kN$	

Design concrete splitting resistance

Verification not necessary since the characteristic resistance for concrete cone failure, concrete blow-out failure and pull-out failure is calculated for cracked concrete and reinforcement resists the splitting forces and limits the crack width to $w_k \le 0.3$ mm.

Design concrete blow-out resistance

Verification not necessary since $c \ge 0.5 \cdot h_{ef}$

$c_1 = 190mm > 0.5 \cdot 91mm = 45.5mm$

5.1.4 SHEAR loading

Design steel resistance special screw without lever arm

	$V_{Rd,s} = \frac{V_{Rk,s}}{\gamma_{Ms}}$	$V_{Rd,s} = \frac{62.7kN}{1.25} = 50.2kN$

Design steel resistance local flexure channel lip

	$V_{Rd,s,l} = \frac{V_{Rk,s,l}}{\gamma_{Ms,l}}$	$V_{Rd,s,l} = \frac{35kN}{1.8} = 19.5kN$

Design concrete pry-out resistance

Anchor 1	$V^1_{Rd,cp} = \frac{k_5 \cdot N^1_{Rk,c}}{\gamma_{Mc}}$	$V^1_{Rd,cp} = \frac{2 \cdot 30.9kN}{1.5} = 41.2kN$
Anchor 2	$V^2_{Rd,cp} = \frac{k_5 \cdot N^2_{Rk,c}}{\gamma_{Mc}}$	$V^1_{Rd,cp} = \frac{2 \cdot 22.4kN}{1.5} = 29.9kN$

Design concrete edge resistance

Basic resistance including reinforcement condition	$V^0_{Rk,c} = \alpha_p \cdot \psi_{re,V} \cdot \sqrt{f_{ck,cube}} \cdot c_1^{1.5}$	$V^0_{Rk,c} = 4.8 \cdot \sqrt{37} \cdot 190^{1.5} = 76.5kN$
Effect of neighboring anchors, anchor 1	$\alpha_{s,V} = \frac{1}{1+\sum_{i=1}^{n}\left[\left(1-\frac{s_i}{s_{cr,V}}\right)^{1.5} \cdot \frac{V_i}{V_0}\right]}$	$\alpha^1_{s,V} = \frac{1}{1+\sum_{i=1}^{1}\left[\left(1-\frac{150}{842}\right)^{1.5} \cdot \frac{1.65}{2.69}\right]} = 0.686$
Effect of neighboring anchors, anchor 2		$\alpha^2_{s,V} = \frac{1}{1+\sum_{i=1}^{1}\left[\left(1-\frac{150}{842}\right)^{1.5} \cdot \frac{2.69}{1.65}\right]} = 0.451$
Effect of corner 1	$\alpha_{c,V} = \left(\frac{c_2}{c_{cr,V}}\right)^{0.5} \le 1.0$	$\alpha^1_{c,V} = \left(\frac{\infty}{421}\right)^{0.5} = \infty > 1.0$
Effect of corner 2		$\alpha^2_{c,V} = \left(\frac{225}{421}\right)^{0.5} = 0.731$
Effect of thickness of structural component	$\alpha_{h,V} = \left(\frac{h}{h_{cr,V}}\right)^{0.5} \le 1.0$	$\alpha_{h,V} = \left(\frac{250}{436}\right)^{0.5} = 0.757$
Efect of load parallel to edge		$\alpha_{90°,V} = 1.0$
Characteristic resistance	$V_{Rk,c} = V^0_{Rk,c} \cdot \alpha_{s,V} \cdot \alpha_{c,V} \cdot \alpha_{h,V} \cdot \alpha_{90°,V}$ Anchor 1: $V^1_{Rk,c} = 76.5 \cdot 0.686 \cdot 1.0 \cdot 0.757 \cdot 1.0 = 39.7kN$ Anchor 2: $V^2_{Rk,c} = 76.5 \cdot 0.451 \cdot 0.731 \cdot 0.757 \cdot 1.0 = 19.1kN$	
Design resistance	Anchor 1: $V_{Rd,c} = \frac{V_{Rk,c}}{\gamma_{Mc}} = 26.5kN$ Anchor 2: $V_{Rd,c} = \frac{V_{Rk,c}}{\gamma_{Mc}} = 12.7kN$	

5.1.5 Combined tension and shear loading

TENSION: Determination of utilization rates direct load (screw loads)

Failure mode	Utilization factor $\beta = \frac{N_{Ed}}{N_{Rd}}$	Utilization factor	Decisive mode
Steel failure local flexure channel lip	β=3.38/13.9	24%	✓
Flexure of channel	β=0.081/0.821	10%	
Special screw	β=3.38/83.7	4%	

TENSION: Determination of utilization rates anchor loads

Failure mode	Utilization factor $\beta_i = \frac{N^a_{Ed,i}}{N_{Rd}}$	Utilization factor	Anchor
Steel failure of anchor	β_1=2.09/18.3	11%	1
	β_2=1.28/18.3	7%	2
Steel failure connection channel – anchor	β_1=2.09/13.9	15%	1
	β_2=1.28/13.9	10%	2
Pull-out	β_1=2.09/15.1	14%	1
	β_2=1.28/15.1	9%	2
Concrete cone failure	β_1=2.09/20.6	10%	1
	β_2=1.28/14.9	9%	2
Splitting failure	N/A		
Blow out	N/A		

SHEAR: Determination of utilization rates direct load (screw loads)

Failure mode	Utilization factor $\beta = \frac{V_{Ed}}{V_{Rd}}$	Utilization factor	Decisive mode
Steel failure special screw	β=4.35/50.2	9%	
Steel failure local channel lip	β=4.35/19.5	23%	✓

SHEAR: Determination of utilization rates anchor loads

Failure mode	Utilization factor $\beta_i = \frac{V^a_{Ed,i}}{V_{Rd}}$	Utilization factor	Anchor
Pry-out	β_1=2.69/41.2	7%	1
	β_2=1.65/29.9	6%	2
concrete edge	β_1=2.69/26.5	10%	1
	β_2=1.65/12.7	13%	2

5.1.6 Load combination direct loads (screw)

Tension: Steel failure local flexure channel lip	24%	
Shear: Steel failure local channel lip	23%	
Interaction steel	$\beta_N^2 + \beta_V^2 \le 1.0$	$0.24^2 + 0.23^2 = 0.12 \le 1$

5.1.7 Load combination anchor loads

Anchor 1:		
Tension: Concrete failure pull-out	14%	
Shear: Concrete failure concrete edge	10%	
Interaction concrete	$\beta_N^{1.5} + \beta_V^{1.5} \le 1.0$	$0.14^{1.5} + 0.10^{1.5} = 0.08 \le 1$
Anchor 2:		
Tension: Concrete failure pull-out	9%	
Shear: Concrete failure concrete edge	13%	
Interaction concrete	$\beta_N^{1.5} + \beta_V^{1.5} \le 1.0$	$0.09^{1.5} + 0.13^{1.5} = 0.07 \le 1$

Attn. **: To whom it may concern**

Date : 28 Apr 2011
Ref. : LE/TC/401/11

Subject : Hilti HAC anchor channel

Dear Sirs / Madams,

Enclosed please find the information of Hilti HAC Anchor Channel.

Brand Name	: Hilti
Model Name	: Hilti HAC-10 / HAC-20 / HAC-30 / HAC-40 / HAC-50 / HAC-60 / HAC-70
Manufacturer	: Hilti Corporation
Address of Manufacturer	: FL-9494, Principality of Liechtenstein.
Supplier	: Hilti (Hong Kong) Ltd
Address of Supplier	: 701-704, 7/F, Tower A, Manulife Financial Centre, 223 Wai Yip Street, Kwun Tong, Kowloon, Hong Kong.
Country of Origin	: Germany

Should you have further questions, please do not hesitate to contact our Technical Representatives or Customer Service Hotline at 8228-8118.

Yours sincerely,
Hilti (Hong Kong) Ltd.

Thomas Choy
Head of Marketing

Hilti (Hong Kong) Limited
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223 Wai Yip Street I Kwun Tong
Kowloon I Hong Kong
P +852-8228 8118 I **F** +852-2954 1751
www.hk.hilti.com

Attn. **: To whom it may concern**

Date : 28 Apr 2011
Ref. : LE/TC/402/11

Subject **: Hilti HAC anchor channel – T-bolts**

Dear Sirs / Madams,

Enclosed please find the information of Hilti HAC Anchor Channel T-bolts.

Brand Name	: Hilti
Model Name	: Hilti HBC-A / HBC-B / HBC-C / HBC-CN / HBC-CE T-bolts
Manufacturer	: Hilti Corporation
Address of Manufacturer	: FL-9494, Principality of Liechtenstein.
Supplier	: Hilti (Hong Kong) Ltd
Address of Supplier	: 701-704, 7/F, Tower A, Manulife Financial Centre, 223 Wai Yip Street, Kwun Tong, Kowloon, Hong Kong.
Country of Origin	: Taiwan

Should you have further questions, please do not hesitate to contact our Technical Representatives or Customer Service Hotline at 8228-8118.

Yours sincerely,
Hilti (Hong Kong) Ltd.

Thomas Choy
Head of Marketing

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www.hk.hilti.com

1. Job / Application Reference for HAC

Year	Project Name	Consultant / RSE	Application
2013	Tung Chung 55B. Lantau Island Curtain Wall	Meinhardt (HK) Ltd	Curtain wall
2013	110A-110B Argyle Street and 10-14A Soares Avenue, Mong Kok, Hong Kong SAR Curtain Wall	WMKY	Curtain wall
2013	33 – 39 Fuk Tsun Street, Shum Shui Po. Kln Curtain Wall	C M Wong & Associates Ltd	Curtain wall
2013	Wan Chai Bypass Pier. Hong Kong	AECOM Asia Company Limited	Balustrade
2013	38 Kwun Chung St.Jordan, Kln.	Wong Pak Lam	Curtain wall
2013	55 Conduit Road. Hong Kong.	Atkins	Curtain wall
2013	Residental Development at 97 Belcher's Street. HK	Alpha/ CM Wong	Curtain wall
2013	Hotal Development at 54 – 60 Portland Street. Mong Kok.	Wong & Cheng Consulting Engineers Ltd	Curtain wall
2013	West Kowloon Terminal	MTRC	Balustrade
2013	Redevelopment of Yan Chai Hospital, Tsuen Wan	Scott Wilson	Curtain wall
2013	HK Open University Ph III Campus. Ho Man Tin	P&T	Gondola Monorail system
2013	Residental Development at 68 Boundary Street	Stephen Cheng	Curtain wall
2013	Commercial Development at 47 Connaught Road, Central	APT	Curtain wall
2013	Residental Development at Austin Station (Site C)	AECOM Asia Company Limited	Cladding
2014	12 Oil Street, North Point Mixed Development (Ex-government Supplies Depot)	AECOM Asia Company Limited	Curtain wall
2014	2 Ng Fong Street Commercial Development	C M Wong & Associates Ltd	Curtain wall
2014	2, 6 & 8 Kennedy Road Residential Development	JMK Consulting Engineers	Curtain wall
2014	24 Po Shan Road Residential Development Central	Wong & Ouyang (Civil-Structural Engineering)	Curtain wall
2014	31 Conduit Road Residential Development	C M Wong & Associates Ltd	Curtain wall
2014	361-367 Portland Street Commercial and Residential Development	K C Wong & Associates Ltd	Curtain wall
2014	41 Heung Yip Road Commercial Development	Jacobs China Limited	Curtain wall
2014	53 Conduit Road Residential Development	AECOM Asia Company Limited	Curtain wall
2014	565-577 Fuk Wah Street Residential and Commercial Development	Stephen Cheng Consulting Engineers Ltd	Curtain wall
2014	7-12 Ying Wa Terrace Residential Development	Stephen Cheng Consulting Engineers Ltd	Curtain wall
2014	82-100 Tak Cheong Street & 2-4 Soy Street Hotel Development,tai Kok Tsui	AECOM Asia Company Limited	Curtain wall
2014	83 Hoi Bun Road Commercial Building	AECOM Asia Company Limited	Curtain wall
2014	Hong Kong Science Park: Phase 3c	Ove Arup & Partners HK Ltd	Curtain wall
2014	Junction of on Kwan Street and on Lai Street, Shek Mun, Sha Tin Commercial Development	C M Wong & Associates Ltd	Curtain wall

1. Job / Application Reference for HAC

Year	Project Name	Consultant / RSE	Application
2014	Junction of on Yiu Street and on Kwan Street, Shek Mun (Sttl 463), Sha Tin , Sha Tin, New Territories	Siu Yin Wai & Associates Ltd	Curtain wall
2014	Residential Development 62 Begonia Road	Wong & Cheng Consulting Engineers Ltd	Curtain wall
2014	Shatin Area 56a, Kau to (Site a) , Sttl 525	AECOM Asia Company Limited	Curtain wall
2014	Yoho Town Commerical Residential Development Phase 3	Sun Hung Kai Architects & Engineers Limited	Curtain wall
2014	33 Seymour Road (Phase 2) Residential Development	C M Wong & Associates Ltd	Curtain wall
2014	Tseung Kwan O Area 66c1 (Tkotl 114), Tseung Kwan O	Sun Hung Kai Architects & Engineers Limited	Curtain wall
2015	(Tkotl 112) Area 65c1, Chi Shin Street, Tseung Kwan O	AECOM Asia Company Limited	Curtain wall
2015	10-12 Kimberley Street, Tsim Sha Tsui , Yau Tsim Mong	Greg Wong & Associates Ltd	Curtain wall
2015	180 Wai Yip Street Commercial Development	C M Wong & Associates Ltd	Curtain wall
2015	187-191 Portland Street Commercial Residential Development	T K Tsui & Associates Ltd	Curtain wall
2015	19-33 Shing on Street Commercial and Residential Development, Sai Wan Ho	Stephen Cheng Consulting Engineers Ltd	Curtain wall
2015	196-202 Ma Tau Wai Road Residential Development	façade consultant/ Inhabit Living Engineering Limited	Curtain wall
2015	2-12 Jones Street & 1-11 Lai Yin Street Residential Development	Siu Yin Wai & Associates Ltd	Curtain wall
2015	279 Prince Edward Road West Residential Development	Yung & Chan Associates Ltd	Curtain wall
2015	3-7 Wing Hing Street, Tin Hau	T K Tsui & Associates Ltd	Curtain wall
2015	38-40a Hillwood Road Commercial Development	Siu Yin Wai & Associates Ltd	Curtain wall
2015	40-40a Kimberley Road & 22a Kimberley Street	AECOM Asia Company Limited	Curtain wall
2015	44 Stubbs Road , Happy Valley, Hong Kong Island	Wong Pak Lam & Associates Consulting Engineers & Architects Ltd	Curtain wall
2015	60-66 Jardine's Bazaar Hotel Development	T K Tsui & Associates Ltd	Curtain wall
2015	680 Castle Peak, Lai Chi Kok , Sham Shui Po District	Sun Hung Kai Architects & Engineers Limited	Curtain wall
2015	77 Peak Road Residential Development	C M Wong & Associates Ltd	Curtain wall
2015	78-88 Sai Yee Street Residential Development	Wong & Cheng Consulting Engineers Ltd	Curtain wall
2015	8-12 Deep Water Bay Drive (Rbl 1190), Shouson Hill , Southern District, Hong Kong Island	AECOM Asia Company Limited	Curtain wall
2015	Goldin Financial Global Centre	Ove Arup & Partners HK Ltd	Curtain wall
2015	Iplace, 301-305 Castle Peak Road, Kwai Chung Section, Kwai Chung , Kwai Tsing District	Siu Yin Wai & Associates Ltd	Curtain wall
2015	Isfa,no.1 Kong Sin Wan Road, Pok Fu Lam	Ove Arup & Partners HK Ltd	Curtain wall
2015	Junction of Sheung Lok Street and Sheung Shing Street, Ho Man Tin (Kil 11227) , Kowloon City District	Siu Yin Wai & Associates Ltd	Curtain wall
2015	Kau to Area 56a (Sttl 579), Lai Ping Road, Sha Tin	AECOM Asia Company Limited	Curtain wall

1. Job / Application Reference for HAC

Year	Project Name	Consultant / RSE	Application
2015	Kensington Hill, 92-98 High Street & 39-45 Western Street Residential Development	JMK Consulting Engineers	Curtain wall
2015	Ocean Terminal, Canton Road , Tsim Sha Tsui, Kowloon	Ove Arup & Partners HK Ltd	Sliding door
2015	Redevelopment of Pak Tai Street/ Mok Cheong Street	C M Wong & Associates Ltd	Curtain wall
2015	Shangri-la Hotel, Kil 11205, Junction of Hung Luen Road and Wa Shun Street, Hung Hom	Ove Arup & Partners HK Ltd	Curtain wall
2015	Skypark,38 Sai Yee Street, Nelson Street and Fa Yuen Street, Mong Kok	C M Wong & Associates Ltd	Curtain wall
2015	Tmtl 423 Area 48, Castle Peak Road, So Kwun Wat	Meinhardt (HK) Ltd	Curtain wall
2015	Tmtl 427 Residential Development, So Kwun Wat Road, Area 56, Tuen Mun	C M Wong & Associates Ltd	Curtain wall
2015	Yoho Town Commerical Residential Development: Phase 3	Sun Hung Kai Architects & Engineers Limited	Curtain wall
2015	Goldin Financial Global Centre	Ove Arup & Partners HK Ltd	Curtain wall
2015	373 Queen's Road East Hotel Development	C M Wong & Associates Ltd	Curtain wall
2015	6-12 Maidstone Road Commercial and Residential Development	Yung & Chan Associates Ltd	Curtain wall
2015	China Unicom Chun Wang Street Date Centre	AECOM Asia Company Limited	Curtain wall

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