




## HST Stud anchor

|   | Anchor version                             | Benefits   |
|---|--|--|
|  | HST<br>Carbon steel                        | - suitable for non-cracked and cracked concrete C 20/25 to C 50/60<br>- quick and simple setting operation<br>- safety wedge for certain follow up expansion |
|  | HST-R<br>Stainless steel                   |  |
|  | HST-HCR<br>High corrosion resistance steel |  |



Concrete



Tensile zone



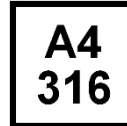
Fire resistance



Shock



Seismic



Corrosion resistance



High corrosion resistance



European Technical Approval



CE conformity



PROFIS  
Anchor design software

### Approvals / certificates

| Description  | Authority / Laboratory                    | No. / date of issue         |
|--|---|-----------------------------|
| European technical approval <sup>a)</sup>            | DIBt, Berlin                              | ETA-98/0001 / 2011-06-17    |
| Shockproof fastenings in civil defence installations | Federal Office for Civil Protection, Bern | BZS D 08-602 / 2008-12-15   |
| Fire test report                                     | DIBt, Berlin                              | ETA-98/0001 / 2011-06-17    |
| Fire test report ZTV-Tunnel                          | IBMB, Braunschweig                        | UB 3332/0881-2 / 2003-07-02 |
| Assessment report (fire)                             | warringtonfire                            | WF 166402 / 2007-10-26      |

a) All data given in this section according ETA-98/0001, issue 2011-06-17.

### Basic loading data (for a single anchor)

All data in this section applies to

- Correct setting (See setting instruction)
- No edge distance and spacing influence
- Concrete as specified in the table
- Steel failure
- Minimum base material thickness
- Concrete C 20/25,  $f_{ck,cube} = 25 \text{ N/mm}^2$

For details see Simplified design method

**Mean ultimate resistance**

| Anchor size           |      | Non-cracked concrete |      |      |      |       |       | Cracked concrete |      |      |      |       |       |
|-----------------------|------|----------------------|------|------|------|-------|-------|------------------|------|------|------|-------|-------|
|                       |      | M8                   | M10  | M12  | M16  | M20   | M24   | M8               | M10  | M12  | M16  | M20   | M24   |
| Tensile $N_{R_{u,m}}$ |      |                      |      |      |      |       |       |                  |      |      |      |       |       |
| HST                   | [kN] | 16,6                 | 22,3 | 35,2 | 48,7 | 76,0  | 86,1  | 10,3             | 11,6 | 21,9 | 31,1 | 44,9  | 60,2  |
| HST-R                 | [kN] | 18,1                 | 26,7 | 35,1 | 49,8 | 77,4  | 79,1  | 12,7             | 18,4 | 20,1 | 36,0 | 55,1  | 70,5  |
| HST-HCR               | [kN] | 15,2                 | 22,7 | 32,4 | 45,5 | -     | -     | 13,8             | 16,2 | 21,5 | 32,4 | -     | -     |
| Shear $V_{R_{u,m}}$   |      |                      |      |      |      |       |       |                  |      |      |      |       |       |
| HST                   | [kN] | 17,6                 | 27,8 | 40,5 | 67,8 | 102,9 | 112,3 | 17,6             | 27,8 | 40,5 | 67,8 | 102,9 | 112,3 |
| HST-R                 | [kN] | 15,8                 | 24,4 | 35,4 | 61,2 | 95,6  | 137,7 | 15,8             | 24,4 | 35,4 | 61,2 | 95,6  | 137,7 |
| HST-HCR               | [kN] | 17,6                 | 27,8 | 40,5 | 75,4 | -     | -     | 17,6             | 27,8 | 40,5 | 75,4 | -     | -     |

**Characteristic resistance**

| Anchor size       |      | Non-cracked concrete |      |      |      |      |       | Cracked concrete |      |      |      |      |       |
|-------------------|------|----------------------|------|------|------|------|-------|------------------|------|------|------|------|-------|
|                   |      | M8                   | M10  | M12  | M16  | M20  | M24   | M8               | M10  | M12  | M16  | M20  | M24   |
| Tensile $N_{R_k}$ |      |                      |      |      |      |      |       |                  |      |      |      |      |       |
| HST               | [kN] | 9,0                  | 16,0 | 20,0 | 35,0 | 50,0 | 60,0  | 5,0              | 9,0  | 12,0 | 20,0 | 30,0 | 40,0  |
| HST-R             | [kN] | 9,0                  | 16,0 | 20,0 | 35,0 | 50,0 | 60,0  | 5,0              | 9,0  | 12,0 | 25,0 | 30,0 | 40,0  |
| HST-HCR           | [kN] | 9,0                  | 16,0 | 20,0 | 35,0 | -    | -     | 5,0              | 9,0  | 12,0 | 25,0 | -    | -     |
| Shear $V_{R_k}$   |      |                      |      |      |      |      |       |                  |      |      |      |      |       |
| HST               | [kN] | 14,0                 | 23,5 | 35,0 | 55,0 | 84,0 | 94,0  | 14,0             | 23,5 | 35,0 | 55,0 | 84,0 | 94,0  |
| HST-R             | [kN] | 13,0                 | 20,0 | 30,0 | 50,0 | 80,0 | 115,0 | 13,0             | 20,0 | 30,0 | 50,0 | 80,0 | 115,0 |
| HST-HCR           | [kN] | 13,0                 | 20,0 | 30,0 | 55,0 | -    | -     | 13,0             | 20,0 | 30,0 | 53,5 | -    | -     |

**Design resistance**

| Anchor size       |      | Non-cracked concrete |      |      |      |      |      | Cracked concrete |      |      |      |      |      |
|-------------------|------|----------------------|------|------|------|------|------|------------------|------|------|------|------|------|
|                   |      | M8                   | M10  | M12  | M16  | M20  | M24  | M8               | M10  | M12  | M16  | M20  | M24  |
| Tensile $N_{R_d}$ |      |                      |      |      |      |      |      |                  |      |      |      |      |      |
| HST               | [kN] | 5,0                  | 10,7 | 13,3 | 23,3 | 33,3 | 40,0 | 2,8              | 6,0  | 8,0  | 13,3 | 20,0 | 26,7 |
| HST-R             | [kN] | 6,0                  | 10,7 | 13,3 | 23,3 | 33,3 | 40,0 | 3,3              | 6,0  | 8,0  | 16,7 | 20,0 | 26,7 |
| HST-HCR           | [kN] | 6,0                  | 10,7 | 13,3 | 23,3 | -    | -    | 3,3              | 6,0  | 8,0  | 16,7 | -    | -    |
| Shear $V_{R_d}$   |      |                      |      |      |      |      |      |                  |      |      |      |      |      |
| HST               | [kN] | 11,2                 | 18,8 | 28,0 | 44,0 | 67,2 | 62,7 | 11,2             | 18,8 | 28,0 | 44,0 | 60,9 | 62,7 |
| HST-R             | [kN] | 10,4                 | 16,0 | 24,0 | 38,5 | 55,6 | 79,9 | 10,4             | 16,0 | 24,0 | 35,6 | 55,6 | 79,9 |
| HST-HCR           | [kN] | 10,4                 | 16,0 | 24,0 | 44,0 | -    | -    | 10,4             | 16,0 | 24,0 | 35,6 | -    | -    |

**Recommended loads**

| Anchor size            |      | Non-cracked concrete |      |      |      |      |      | Cracked concrete |      |      |      |      |      |
|------------------------|------|----------------------|------|------|------|------|------|------------------|------|------|------|------|------|
|                        |      | M8                   | M10  | M12  | M16  | M20  | M24  | M8               | M10  | M12  | M16  | M20  | M24  |
| Tensile $N_{rec}^{a)}$ |      |                      |      |      |      |      |      |                  |      |      |      |      |      |
| HST                    | [kN] | 3,6                  | 7,6  | 9,5  | 16,7 | 23,8 | 28,6 | 2,0              | 4,3  | 5,7  | 9,5  | 14,3 | 19,0 |
| HST-R                  | [kN] | 4,3                  | 7,6  | 9,5  | 16,7 | 23,8 | 28,6 | 2,4              | 4,3  | 5,7  | 11,9 | 14,3 | 19,0 |
| HST-HCR                | [kN] | 4,3                  | 7,6  | 9,5  | 16,7 | -    | -    | 2,4              | 4,3  | 5,7  | 11,9 | -    | -    |
| Shear $V_{rec}^{a)}$   |      |                      |      |      |      |      |      |                  |      |      |      |      |      |
| HST                    | [kN] | 8,0                  | 13,4 | 20,0 | 31,4 | 48,0 | 44,8 | 8,0              | 13,4 | 20,0 | 31,4 | 43,5 | 44,8 |
| HST-R                  | [kN] | 7,4                  | 11,4 | 17,1 | 27,5 | 39,7 | 57,0 | 7,4              | 11,4 | 17,1 | 25,5 | 39,7 | 57,0 |
| HST-HCR                | [kN] | 7,4                  | 11,4 | 17,1 | 31,4 | -    | -    | 7,4              | 11,4 | 17,1 | 25,5 | -    | -    |

a) With overall partial safety factor for action  $\gamma = 1,4$ . The partial safety factors for action depend on the type of loading and shall be taken from national regulations.

## Materials

### Mechanical properties of HST, HST-R, HST-HCR

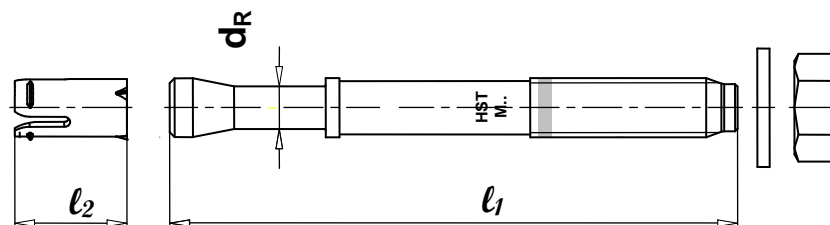
| Anchor size                           |                              | M8   | M10  | M12   | M16   | M20   | M24   |
|---------------------------------------|------------------------------|------|------|-------|-------|-------|-------|
| Nominal tensile strength $f_{uk}$     | HST [N/mm <sup>2</sup> ]     | 800  | 800  | 800   | 720   | 700   | 530   |
|                                       | HST-R [N/mm <sup>2</sup> ]   | 720  | 700  | 700   | 650   | 650   | 650   |
|                                       | HST-HCR [N/mm <sup>2</sup> ] | 800  | 800  | 800   | 800   | -     | -     |
| Yield strength $f_{yk}$               | HST [N/mm <sup>2</sup> ]     | 640  | 640  | 640   | 580   | 560   | 451   |
|                                       | HST-R [N/mm <sup>2</sup> ]   | 575  | 560  | 560   | 500   | 450   | 450   |
|                                       | HST-HCR [N/mm <sup>2</sup> ] | 640  | 640  | 640   | 640   | -     | -     |
| Stressed cross-section $A_s$          | [mm <sup>2</sup> ]           | 36,6 | 58,0 | 84,3  | 157   | 245   | 353   |
| Moment of resistance $W$              | [mm <sup>3</sup> ]           | 31,2 | 62,3 | 109,2 | 277,5 | 540,9 | 935,5 |
| Char. bending resistance $M_{Rk,s}^0$ | HST [Nm]                     | 30   | 60   | 105   | 240   | 454   | 595   |
|                                       | HST-R [Nm]                   | 27   | 53   | 92    | 216   | 422   | 730   |
|                                       | HST-HCR [Nm]                 | 30   | 60   | 105   | 266   | -     | -     |

### Material quality

| Part | Material |  |
|------|----------|--|
| Bolt | HST      | Carbon steel, galvanised to min. 5 $\mu$ m |
|      | HST-R    | Stainless steel                            |
|      | HST-HCR  | High corrosion resistant steel             |

## Anchor dimensions

| Anchor size                  |                    | M8   | M10  | M12  | M16  | M20  | M24  |
|------------------------------|--------------------|------|------|------|------|------|------|
| Minimum thickness of fixture | $t_{fix,min}$ [mm] | 2    | 2    | 2    | 2    | 2    | 2    |
| Maximum thickness of fixture | $t_{fix,max}$ [mm] | 195  | 200  | 200  | 235  | 305  | 330  |
| Shaft diameter at the cone   | $d_R$ [mm]         | 5,5  | 7,2  | 8,5  | 11,6 | 14,6 | 17,4 |
| Minimum length of the anchor | $l_{1,min}$ [mm]   | 75   | 90   | 115  | 140  | 170  | 200  |
| Maximum length of the anchor | $l_{1,max}$ [mm]   | 260  | 280  | 295  | 350  | 450  | 500  |
| Length of expansion sleeve   | $l_2$ [mm]         | 14,8 | 18,2 | 22,7 | 24,3 | 28,3 | 36   |

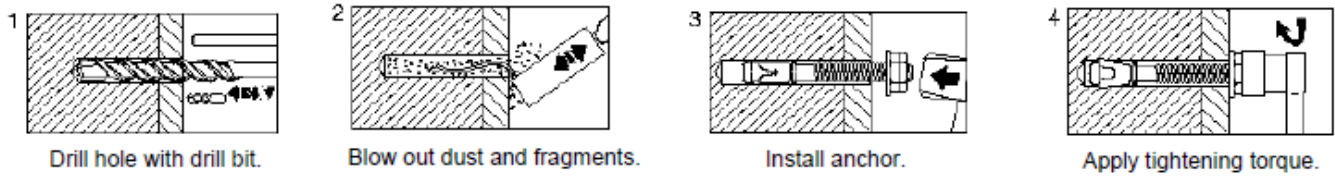


## Setting

### Installation equipment

| Anchor size   | M8                                   | M10 | M12 | M16 | M20         | M24 |
|---------------|--------------------------------------|-----|-----|-----|-------------|-----|
| Rotary hammer | TE2 – TE16                           |     |     |     | TE40 – TE70 |     |
| Other tools   | hammer, torque wrench, blow out pump |     |     |     |             |     |

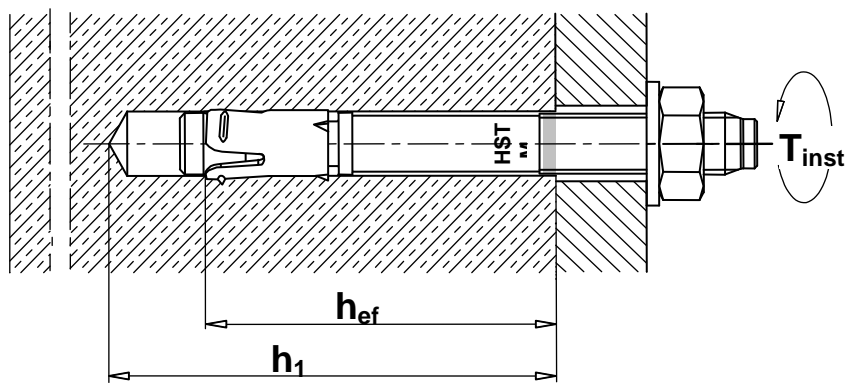
### Setting instruction



For detailed information on installation see instruction for use given with the package of the product.

For technical data for anchors in diamond drilled holes please contact the Hilti Technical advisory service.

### Setting details: depth of drill hole $h_1$ and effective anchorage depth $h_{ef}$

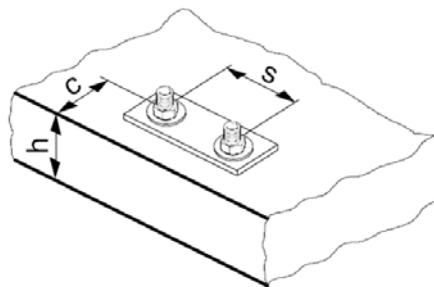


### Setting details HST, HST-R, HST-HCR

|   |                     | M8   | M10   | M12  | M16  | M20   | M24   |
|---|---------------------|------|-------|------|------|-------|-------|
| Nominal diameter of drill bit             | $d_o$ [mm]          | 8    | 10    | 12   | 16   | 20    | 24    |
| Cutting diameter of drill bit             | $d_{cut} \leq$ [mm] | 8,45 | 10,45 | 12,5 | 16,5 | 20,55 | 24,55 |
| Depth of drill hole                       | $h_1 \geq$ [mm]     | 65   | 80    | 95   | 115  | 140   | 170   |
| Diameter of clearance hole in the fixture | $d_f \leq$ [mm]     | 9    | 12    | 14   | 18   | 22    | 26    |
| Effective anchorage depth                 | $h_{ef}$ [mm]       | 47   | 60    | 70   | 82   | 101   | 125   |
| Torque moment                             | $T_{inst}$ [Nm]     | 20   | 45    | 60   | 110  | 240   | 300   |
| Width across                              | SW [mm]             | 13   | 17    | 19   | 24   | 30    | 36    |

## Setting parameters

| Anchor size  |                  |   | M8   | M10 | M12 | M16 | M20 | M24 |     |
|--|------------------|---|------|-----|-----|-----|-----|-----|-----|
| Minimum base material thickness  |                  | $h_{\min}$                              | [mm] | 100 | 120 | 140 | 160 | 200 | 250 |
| Minimum spacing in non-cracked concrete                                | HST              | $s_{\min}$                              | [mm] | 60  | 55  | 60  | 70  | 100 | 125 |
|  |                  | for $c \geq$                            | [mm] | 50  | 80  | 85  | 110 | 225 | 255 |
|  | HST-R            | $s_{\min}$                              | [mm] | 60  | 55  | 60  | 70  | 100 | 125 |
|  |                  | for $c \geq$                            | [mm] | 60  | 70  | 80  | 110 | 195 | 205 |
|  | HST-HCR          | $s_{\min}$                              | [mm] | 60  | 55  | 60  | 70  | -   | -   |
|  |                  | for $c \geq$                            | [mm] | 50  | 70  | 80  | 110 | -   | -   |
| Minimum spacing in cracked concrete                                    | HST              | $s_{\min}$                              | [mm] | 40  | 55  | 60  | 70  | 100 | 125 |
|  |                  | for $c \geq$                            | [mm] | 50  | 70  | 75  | 100 | 160 | 180 |
|  | HST-R            | $s_{\min}$                              | [mm] | 40  | 55  | 60  | 70  | 100 | 125 |
|  |                  | for $c \geq$                            | [mm] | 50  | 65  | 75  | 100 | 130 | 130 |
|  | HST-HCR          | $s_{\min}$                              | [mm] | 40  | 55  | 60  | 70  | -   | -   |
|  |                  | for $c \geq$                            | [mm] | 50  | 70  | 75  | 100 | -   | -   |
| Minimum edge distance in non-cracked concrete                          | HST              | $c_{\min}$                              | [mm] | 50  | 55  | 55  | 85  | 140 | 170 |
|  |                  | for $s \geq$                            | [mm] | 60  | 115 | 145 | 150 | 270 | 295 |
|  | HST-R            | $c_{\min}$                              | [mm] | 60  | 50  | 55  | 70  | 140 | 150 |
|  |                  | for $s \geq$                            | [mm] | 60  | 115 | 145 | 160 | 210 | 235 |
|  | HST-HCR          | $c_{\min}$                              | [mm] | 60  | 55  | 55  | 70  | -   | -   |
|  |                  | for $s \geq$                            | [mm] | 60  | 115 | 145 | 160 | -   | -   |
| Minimum edge distance in cracked concrete                              | HST              | $c_{\min}$                              | [mm] | 45  | 55  | 55  | 70  | 100 | 125 |
|  |                  | for $s \geq$                            | [mm] | 50  | 90  | 120 | 150 | 225 | 240 |
|  | HST-R<br>HST-HCR | $c_{\min}$                              | [mm] | 45  | 50  | 55  | 60  | 100 | 125 |
|  |                  | for $s \geq$                            | [mm] | 50  | 90  | 110 | 160 | 160 | 140 |
| Critical spacing for splitting failure and concrete cone failure       |                  | $s_{\text{cr,sp}}$<br>$s_{\text{cr,N}}$ | [mm] | 141 | 180 | 210 | 246 | 303 | 375 |
| Critical edge distance for splitting failure and concrete cone failure |                  | $c_{\text{cr,sp}}$<br>$c_{\text{cr,N}}$ | [mm] | 71  | 90  | 105 | 123 | 152 | 188 |



For spacing (edge distance) smaller than critical spacing (critical edge distance) the design loads have to be reduced.

## Simplified design method

Simplified version of the design method according ETAG 001, Annex C. Design resistance according data given in ETA-98/0001, issue 2011-06-17.

- Influence of concrete strength
- Influence of edge distance
- Influence of spacing
- Valid for a group of two anchors. (The method may also be applied for anchor groups with more than two anchors or more than one edge. The influencing factors must then be considered for each edge distance and spacing. The calculated design loads are then on the same side: They will be lower than the exact

values according ETAG 001, Annex C. To avoid this, it is recommended to use the anchor design software PROFIS anchor)

The design method is based on the following simplification:

- No different loads are acting on individual anchors (no eccentricity)

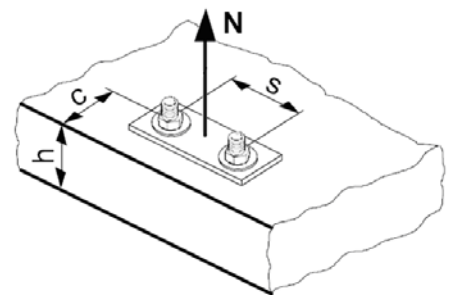
The values are valid for one anchor.

For more complex fastening applications please use the anchor design software PROFIS Anchor.

### Tension loading

The design tensile resistance is the lower value of

- Steel resistance:  $N_{Rd,s}$
- Concrete pull-out resistance:  $N_{Rd,p} = N_{Rd,p}^0 \cdot f_B$
- Concrete cone resistance:  $N_{Rd,c} = N_{Rd,c}^0 \cdot f_B \cdot f_{1,N} \cdot f_{2,N} \cdot f_{3,N} \cdot f_{re,N}$
- Concrete splitting resistance (only non-cracked concrete):  
 $N_{Rd,sp} = N_{Rd,c}^0 \cdot f_B \cdot f_{1,sp} \cdot f_{2,sp} \cdot f_{3,sp} \cdot f_{h,sp} \cdot f_{re,N}$



### Basic design tensile resistance

Design steel resistance  $N_{Rd,s}$

| Anchor size |              | M8   | M10  | M12  | M16  | M20  | M24  |
|-------------|--------------|------|------|------|------|------|------|
| $N_{Rd,s}$  | HST [kN]     | 12,7 | 21,3 | 30,0 | 50,7 | 78,0 | 90,1 |
|             | HST-R [kN]   | 11,3 | 18,7 | 26,7 | 44,2 | 63,0 | 90,2 |
|             | HST-HCR [kN] | 12,9 | 21,5 | 30,5 | 56,3 | -    | -    |

Design pull-out resistance  $N_{Rd,p} = N_{Rd,p}^0 \cdot f_B$

| Anchor size  |              | Non-cracked concrete |      |      |      |      |      | Cracked concrete |     |     |      |      |      |
|--------------|--------------|----------------------|------|------|------|------|------|------------------|-----|-----|------|------|------|
|              |              | M8                   | M10  | M12  | M16  | M20  | M24  | M8               | M10 | M12 | M16  | M20  | M24  |
| $N_{Rd,p}^0$ | HST [kN]     | 5,0                  | 10,7 | 13,3 | 23,3 | 33,3 | 40,0 | 2,8              | 6,0 | 8,0 | 13,3 | 20,0 | 26,7 |
|              | HST-R [kN]   | 6,0                  | 10,7 | 13,3 | 23,3 | 33,3 | 40,0 | 3,3              | 6,0 | 8,0 | 16,7 | 20,0 | 26,7 |
|              | HST-HCR [kN] | 6,0                  | 10,7 | 13,3 | 23,3 | -    | -    | 3,3              | 6,0 | 8,0 | 16,7 | -    | -    |

Design concrete cone resistance  $N_{Rd,c} = N_{Rd,c}^0 \cdot f_B \cdot f_{1,N} \cdot f_{2,N} \cdot f_{3,N} \cdot f_{re,N}$

Design splitting resistance <sup>a)</sup>  $N_{Rd,sp} = N_{Rd,c}^0 \cdot f_B \cdot f_{1,sp} \cdot f_{2,sp} \cdot f_{3,sp} \cdot f_{h,sp} \cdot f_{re,N}$

| Anchor size  |              | Non-cracked concrete |      |      |      |      |     | Cracked concrete |      |      |      |      |      |
|--------------|--------------|----------------------|------|------|------|------|-----|------------------|------|------|------|------|------|
|              |              | M8                   | M10  | M12  | M16  | M20  | M24 | M8               | M10  | M12  | M16  | M20  | M24  |
| $N_{Rd,c}^0$ | HST [kN]     | 9,0                  | 15,6 | 19,7 | 24,9 | 34,1 | 47  | 6,4              | 11,2 | 14,1 | 17,8 | 24,4 | 33,5 |
|              | HST-R [kN]   | 10,8                 | 15,6 | 19,7 | 24,9 | 34,1 | 47  | 7,7              | 11,2 | 14,1 | 17,8 | 24,4 | 33,5 |
|              | HST-HCR [kN] | 10,8                 | 15,6 | 19,7 | 24,9 | -    | -   | 7,7              | 11,2 | 14,1 | 17,8 | -    | -    |

a) Splitting resistance must only be considered for non-cracked concrete

## Influencing factors

### Influence of concrete strength

| Concrete strength designation (ENV 206) | C 20/25 | C 25/30 | C 30/37 | C 35/45 | C 40/50 | C 45/55 | C 50/60 |
|---|---------|---------|---------|---------|---------|---------|---------|
| $f_B = (f_{ck,cube}/25N/mm^2)^{1/2}$ a) | 1       | 1,1     | 1,22    | 1,34    | 1,41    | 1,48    | 1,55    |

a)  $f_{ck,cube}$  = concrete compressive strength, measured on cubes with 150 mm side length

### Influence of edge distance a)

| $c/c_{cr,N}$                                    | 0,1  | 0,2  | 0,3  | 0,4  | 0,5  | 0,6  | 0,7  | 0,8  | 0,9  | 1 |
|---|------|------|------|------|------|------|------|------|------|---|
| $c/c_{cr,sp}$                                   |      |      |      |      |      |      |      |      |      |   |
| $f_{1,N} = 0,7 + 0,3 \cdot c/c_{cr,N} \leq 1$   | 0,73 | 0,76 | 0,79 | 0,82 | 0,85 | 0,88 | 0,91 | 0,94 | 0,97 | 1 |
| $f_{1,sp} = 0,7 + 0,3 \cdot c/c_{cr,sp} \leq 1$ |      |      |      |      |      |      |      |      |      |   |
| $f_{2,N} = 0,5 \cdot (1 + c/c_{cr,N}) \leq 1$   | 0,55 | 0,60 | 0,65 | 0,70 | 0,75 | 0,80 | 0,85 | 0,90 | 0,95 | 1 |
| $f_{2,sp} = 0,5 \cdot (1 + c/c_{cr,sp}) \leq 1$ |      |      |      |      |      |      |      |      |      |   |

a) The edge distance shall not be smaller than the minimum edge distance  $c_{min}$  given in the table with the setting details. These influencing factors must be considered for every edge distance.

### Influence of anchor spacing a)

| $s/s_{cr,N}$                                    | 0,1  | 0,2  | 0,3  | 0,4  | 0,5  | 0,6  | 0,7  | 0,8  | 0,9  | 1 |
|---|------|------|------|------|------|------|------|------|------|---|
| $s/s_{cr,sp}$                                   |      |      |      |      |      |      |      |      |      |   |
| $f_{3,N} = 0,5 \cdot (1 + s/s_{cr,N}) \leq 1$   | 0,55 | 0,60 | 0,65 | 0,70 | 0,75 | 0,80 | 0,85 | 0,90 | 0,95 | 1 |
| $f_{3,sp} = 0,5 \cdot (1 + s/s_{cr,sp}) \leq 1$ |      |      |      |      |      |      |      |      |      |   |

a) The anchor spacing shall not be smaller than the minimum anchor spacing  $s_{min}$  given in the table with the setting details. This influencing factor must be considered for every anchor spacing.

### Influence of base material thickness

| $h/h_{ef}$                              | 2,0 | 2,2  | 2,4  | 2,6  | 2,8  | 3,0  | 3,2  | 3,4  | 3,6  | ≥ 3,68 |
|---|-----|------|------|------|------|------|------|------|------|--------|
| $f_{h,sp} = [h/(2 \cdot h_{ef})]^{2/3}$ | 1   | 1,07 | 1,13 | 1,19 | 1,25 | 1,31 | 1,37 | 1,42 | 1,48 | 1,5    |

### Influence of reinforcement

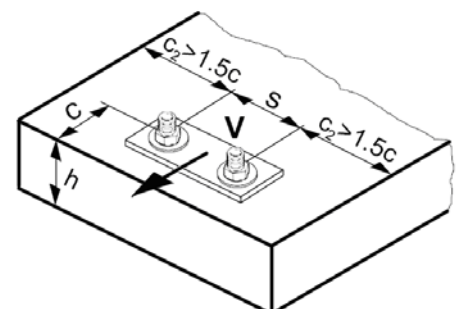
| Anchor size                            | M8                 | M10               | M12                | M16                | M20 | M24 |
|--|--------------------|-------------------|--------------------|--------------------|-----|-----|
| $f_{re,N} = 0,5 + h_{ef}/200mm \leq 1$ | 0,74 <sup>a)</sup> | 0,8 <sup>a)</sup> | 0,85 <sup>a)</sup> | 0,91 <sup>a)</sup> | 1   | 1   |

a) This factor applies only for dense reinforcement. If in the area of anchorage there is reinforcement with a spacing  $\geq 150$  mm (any diameter) or with a diameter  $\leq 10$  mm and a spacing  $\geq 100$  mm, then a factor  $f_{re,N} = 1$  may be applied.

## Shear loading

The design shear resistance is the lower value of

- Steel resistance:  $V_{Rd,s}$
- Concrete pryout resistance:  $V_{Rd,cp} = k \cdot N_{Rd,c}$
- Concrete edge resistance:  $V_{Rd,c} = V_{Rd,c}^0 \cdot f_B \cdot f_h \cdot f_4 \cdot f_{hef} \cdot f_c$



### Basic design shear resistance

#### Design steel resistance $V_{Rd,s}$

| Anchor size |              | M8   | M10  | M12  | M16  | M20  | M24  |
|-------------|--------------|------|------|------|------|------|------|
| $V_{Rd,s}$  | HST [kN]     | 11,2 | 18,8 | 28,0 | 44,0 | 67,2 | 62,7 |
|             | HST-R [kN]   | 10,4 | 16,0 | 24,0 | 38,5 | 55,6 | 79,9 |
|             | HST-HCR [kN] | 10,4 | 16,0 | 24,0 | 44,0 | -    | -    |

#### Design concrete pryout resistance $V_{Rd,cp} = k \cdot N_{Rd,c}$ <sup>a)</sup>

| Anchor size | M8 | M10 | M12 | M16 | M20 | M24 |
|-------------|----|-----|-----|-----|-----|-----|
| k           | 2  | 2   | 2,2 | 2,5 | 2,5 | 2,5 |

a)  $N_{Rd,c}$ : Design concrete cone resistance

#### Design concrete edge resistance $V_{Rd,c} = V_{Rd,c}^0 \cdot f_B \cdot f_\beta \cdot f_h \cdot f_4 \cdot f_{hef} \cdot f_c$

| Anchor size       | Non-cracked concrete |     |      |      |      |      | Cracked concrete |     |     |      |      |      |
|-------------------|----------------------|-----|------|------|------|------|------------------|-----|-----|------|------|------|
|                   | M8                   | M10 | M12  | M16  | M20  | M24  | M8               | M10 | M12 | M16  | M20  | M24  |
| $V_{Rd,c}^0$ [kN] | 5,9                  | 8,6 | 11,7 | 18,9 | 27,3 | 37,1 | 4,2              | 6,1 | 8,3 | 13,4 | 19,3 | 26,3 |

a) For anchor groups only the anchors close to the edge must be considered.

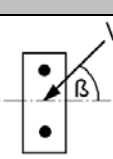
### Influencing factors

#### Influence of concrete strength

| Concrete strength designation (ENV 206)            | C 20/25 | C 25/30 | C 30/37 | C 35/45 | C 40/50 | C 45/55 | C 50/60 |
|--|---------|---------|---------|---------|---------|---------|---------|
| $f_B = (f_{ck,cube}/25N/mm^2)^{1/2}$ <sup>a)</sup> | 1       | 1,1     | 1,22    | 1,34    | 1,41    | 1,48    | 1,55    |

a)  $f_{ck,cube}$  = concrete compressive strength, measured on cubes with 150 mm side length

#### Influence of angle between load applied and the direction perpendicular to the free edge

| Angle $\beta$   | 0° | 10°  | 20°  | 30°  | 40°  | 50°  | 60°  | 70°  | 80°  | ≥ 90° |
|---|----|------|------|------|------|------|------|------|------|-------|
| $f_\beta = \sqrt{\frac{1}{(\cos \alpha_v)^2 + \left(\frac{\sin \alpha_v}{2,5}\right)^2}}$  | 1  | 1,01 | 1,05 | 1,13 | 1,24 | 1,40 | 1,64 | 1,97 | 2,32 | 2,50  |

#### Influence of base material thickness

| h/c                                      | 0,15 | 0,3  | 0,45 | 0,6  | 0,75 | 0,9  | 1,05 | 1,2  | 1,35 | ≥ 1,5 |
|--|------|------|------|------|------|------|------|------|------|-------|
| $f_h = \{h/(1,5 \cdot c)\}^{1/2} \leq 1$ | 0,32 | 0,45 | 0,55 | 0,63 | 0,71 | 0,77 | 0,84 | 0,89 | 0,95 | 1,00  |



**Influence of anchor spacing and edge distance <sup>a)</sup> for concrete edge resistance:  $f_4$** 

$$f_4 = (c/h_{ef})^{1,5} \cdot (1 + s / [3 \cdot c]) \cdot 0,5$$

| c/h <sub>ef</sub> | Single anchor | Group of two anchors s/h <sub>ef</sub> |      |      |      |      |      |      |      |      |      |      |      |       |       |       |
|-------------------|---------------|--|------|------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
|                   |               | 0,75                                   | 1,50 | 2,25 | 3,00 | 3,75 | 4,50 | 5,25 | 6,00 | 6,75 | 7,50 | 8,25 | 9,00 | 9,75  | 10,50 | 11,25 |
| 0,50              | 0,35          | 0,27                                   | 0,35 | 0,35 | 0,35 | 0,35 | 0,35 | 0,35 | 0,35 | 0,35 | 0,35 | 0,35 | 0,35 | 0,35  | 0,35  | 0,35  |
| 0,75              | 0,65          | 0,43                                   | 0,54 | 0,65 | 0,65 | 0,65 | 0,65 | 0,65 | 0,65 | 0,65 | 0,65 | 0,65 | 0,65 | 0,65  | 0,65  | 0,65  |
| 1,00              | 1,00          | 0,63                                   | 0,75 | 0,88 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00  | 1,00  | 1,00  |
| 1,25              | 1,40          | 0,84                                   | 0,98 | 1,12 | 1,26 | 1,40 | 1,40 | 1,40 | 1,40 | 1,40 | 1,40 | 1,40 | 1,40 | 1,40  | 1,40  | 1,40  |
| 1,50              | 1,84          | 1,07                                   | 1,22 | 1,38 | 1,53 | 1,68 | 1,84 | 1,84 | 1,84 | 1,84 | 1,84 | 1,84 | 1,84 | 1,84  | 1,84  | 1,84  |
| 1,75              | 2,32          | 1,32                                   | 1,49 | 1,65 | 1,82 | 1,98 | 2,15 | 2,32 | 2,32 | 2,32 | 2,32 | 2,32 | 2,32 | 2,32  | 2,32  | 2,32  |
| 2,00              | 2,83          | 1,59                                   | 1,77 | 1,94 | 2,12 | 2,30 | 2,47 | 2,65 | 2,83 | 2,83 | 2,83 | 2,83 | 2,83 | 2,83  | 2,83  | 2,83  |
| 2,25              | 3,38          | 1,88                                   | 2,06 | 2,25 | 2,44 | 2,63 | 2,81 | 3,00 | 3,19 | 3,38 | 3,38 | 3,38 | 3,38 | 3,38  | 3,38  | 3,38  |
| 2,50              | 3,95          | 2,17                                   | 2,37 | 2,57 | 2,77 | 2,96 | 3,16 | 3,36 | 3,56 | 3,76 | 3,95 | 3,95 | 3,95 | 3,95  | 3,95  | 3,95  |
| 2,75              | 4,56          | 2,49                                   | 2,69 | 2,90 | 3,11 | 3,32 | 3,52 | 3,73 | 3,94 | 4,15 | 4,35 | 4,56 | 4,56 | 4,56  | 4,56  | 4,56  |
| 3,00              | 5,20          | 2,81                                   | 3,03 | 3,25 | 3,46 | 3,68 | 3,90 | 4,11 | 4,33 | 4,55 | 4,76 | 4,98 | 5,20 | 5,20  | 5,20  | 5,20  |
| 3,25              | 5,86          | 3,15                                   | 3,38 | 3,61 | 3,83 | 4,06 | 4,28 | 4,51 | 4,73 | 4,96 | 5,18 | 5,41 | 5,63 | 5,86  | 5,86  | 5,86  |
| 3,50              | 6,55          | 3,51                                   | 3,74 | 3,98 | 4,21 | 4,44 | 4,68 | 4,91 | 5,14 | 5,38 | 5,61 | 5,85 | 6,08 | 6,31  | 6,55  | 6,55  |
| 3,75              | 7,26          | 3,87                                   | 4,12 | 4,36 | 4,60 | 4,84 | 5,08 | 5,33 | 5,57 | 5,81 | 6,05 | 6,29 | 6,54 | 6,78  | 7,02  | 7,26  |
| 4,00              | 8,00          | 4,25                                   | 4,50 | 4,75 | 5,00 | 5,25 | 5,50 | 5,75 | 6,00 | 6,25 | 6,50 | 6,75 | 7,00 | 7,25  | 7,50  | 7,75  |
| 4,25              | 8,76          | 4,64                                   | 4,90 | 5,15 | 5,41 | 5,67 | 5,93 | 6,18 | 6,44 | 6,70 | 6,96 | 7,22 | 7,47 | 7,73  | 7,99  | 8,25  |
| 4,50              | 9,55          | 5,04                                   | 5,30 | 5,57 | 5,83 | 6,10 | 6,36 | 6,63 | 6,89 | 7,16 | 7,42 | 7,69 | 7,95 | 8,22  | 8,49  | 8,75  |
| 4,75              | 10,35         | 5,45                                   | 5,72 | 5,99 | 6,27 | 6,54 | 6,81 | 7,08 | 7,36 | 7,63 | 7,90 | 8,17 | 8,45 | 8,72  | 8,99  | 9,26  |
| 5,00              | 11,18         | 5,87                                   | 6,15 | 6,43 | 6,71 | 6,99 | 7,27 | 7,55 | 7,83 | 8,11 | 8,39 | 8,66 | 8,94 | 9,22  | 9,50  | 9,78  |
| 5,25              | 12,03         | 6,30                                   | 6,59 | 6,87 | 7,16 | 7,45 | 7,73 | 8,02 | 8,31 | 8,59 | 8,88 | 9,17 | 9,45 | 9,74  | 10,02 | 10,31 |
| 5,50              | 12,90         | 6,74                                   | 7,04 | 7,33 | 7,62 | 7,92 | 8,21 | 8,50 | 8,79 | 9,09 | 9,38 | 9,67 | 9,97 | 10,26 | 10,55 | 10,85 |

- a) The anchor spacing and the edge distance shall not be smaller than the minimum anchor spacing  $s_{min}$  and the minimum edge distance  $c_{min}$ .

**Influence of embedment depth**

| Anchor size                                | M8   | M10  | M12  | M16  | M20  | M24  |
|--|------|------|------|------|------|------|
| $f_{hef} = 0,05 \cdot (h_{ef} / d)^{1,68}$ | 0,98 | 1,01 | 0,97 | 0,78 | 0,76 | 0,80 |

**Influence of edge distance <sup>a)</sup>**

| c/d                    | 4    | 6    | 8    | 10   | 15   | 20   | 30   | 40   |
|------------------------|------|------|------|------|------|------|------|------|
| $f_c = (d / c)^{0,19}$ | 0,77 | 0,71 | 0,67 | 0,65 | 0,60 | 0,57 | 0,52 | 0,50 |

- a) The edge distance shall not be smaller than the minimum edge distance  $c_{min}$ .

**Combined tension and shear loading**

For combined tension and shear loading see section "Anchor Design".

**Precalculated values**

Design resistance calculated according ETAG 001, Annex C and data given in ETA-98/0001, issue 2011-06-17. All data applies to concrete C 20/25 –  $f_{ck,cube} = 25 \text{ N/mm}^2$ .

Recommended loads can be calculated by dividing the design resistance by an overall partial safety factor for action  $\gamma = 1,4$ . The partial safety factors for action depend on the type of loading and shall be taken from national regulations.

### Design resistance

#### Single anchor, no edge effects

| Anchor size                                 |   |      | Non-cracked concrete |      |      |      |      |      | Cracked concrete |      |      |      |      |      |
|---|---|------|----------------------|------|------|------|------|------|------------------|------|------|------|------|------|
|   |   |      | M8                   | M10  | M12  | M16  | M20  | M24  | M8               | M10  | M12  | M16  | M20  | M24  |
| Min. base material thickness $h_{min}$ [mm] |   |      | 100                  | 120  | 140  | 160  | 200  | 250  | 100              | 120  | 140  | 160  | 200  | 250  |
|   | <b>Tensile <math>N_{Rd}</math></b>                  |      |                      |      |      |      |      |      |                  |      |      |      |      |      |
|   | HST   | [kN] | 5,0                  | 10,7 | 13,3 | 23,3 | 33,3 | 40,0 | 2,8              | 6,0  | 8,0  | 13,3 | 20,0 | 26,7 |
|   | HST-R   | [kN] | 6,0                  | 10,7 | 13,3 | 23,3 | 33,3 | 40,0 | 3,3              | 6,0  | 8,0  | 16,7 | 20,0 | 26,7 |
|   | HST-HCR   | [kN] | 6,0                  | 10,7 | 13,3 | 23,3 | -    | -    | 3,3              | 6,0  | 8,0  | 16,7 | -    | -    |
|   | <b>Shear <math>V_{Rd}</math>, without lever arm</b> |      |                      |      |      |      |      |      |                  |      |      |      |      |      |
|   | HST   | [kN] | 11,2                 | 18,8 | 28,0 | 44,0 | 67,2 | 62,7 | 11,2             | 18,8 | 28,0 | 44,0 | 60,9 | 62,7 |
|   | HST-R   | [kN] | 10,4                 | 16,0 | 24,0 | 38,5 | 55,6 | 79,9 | 10,4             | 16,0 | 24,0 | 38,5 | 55,6 | 79,9 |
|   | HST-HCR   | [kN] | 10,4                 | 16,0 | 24,0 | 44,0 | -    | -    | 10,4             | 16,0 | 24,0 | 44,0 | -    | -    |

#### Single anchor, min. edge distance ( $c = c_{min}$ )

| Anchor size                                 |   |      | Non-cracked concrete |      |      |      |      |      | Cracked concrete |     |     |      |      |      |
|---|---|------|----------------------|------|------|------|------|------|------------------|-----|-----|------|------|------|
|   |   |      | M8                   | M10  | M12  | M16  | M20  | M24  | M8               | M10 | M12 | M16  | M20  | M24  |
| Min. base material thickness $h_{min}$ [mm] |   |      | 100                  | 120  | 140  | 160  | 200  | 250  | 100              | 120 | 140 | 160  | 200  | 250  |
| Min. edge distance $c_{min}$                | HST   | [mm] | 50                   | 55   | 55   | 85   | 140  | 170  | 45               | 55  | 55  | 70   | 100  | 125  |
|   | HST-R   | [mm] | 60                   | 50   | 55   | 70   | 140  | 150  | 45               | 50  | 55  | 60   | 100  | 125  |
|   | HST-HCR   | [mm] | 60                   | 55   | 55   | 70   | -    | -    | 45               | 50  | 55  | 60   | -    | -    |
|   | <b>Tensile <math>N_{Rd}</math></b>                  |      |                      |      |      |      |      |      |                  |     |     |      |      |      |
|   | HST   | [kN] | 5,0                  | 10,7 | 12,9 | 19,1 | 32,1 | 40,0 | 2,8              | 6,0 | 8,0 | 12,2 | 18,2 | 25,2 |
|   | HST-R   | [kN] | 6,0                  | 10,5 | 12,9 | 17,0 | 32,1 | 39,7 | 3,3              | 6,0 | 8,0 | 11,2 | 18,2 | 25,2 |
|   | HST-HCR   | [kN] | 6,0                  | 10,7 | 12,9 | 17,0 | -    | -    | 3,3              | 6,0 | 8,0 | 11,2 | -    | -    |
|   | <b>Shear <math>V_{Rd}</math>, without lever arm</b> |      |                      |      |      |      |      |      |                  |     |     |      |      |      |
|   | HST   | [kN] | 4,5                  | 5,6  | 5,9  | 11,3 | 22,8 | 32,0 | 2,8              | 3,9 | 4,2 | 6,2  | 10,7 | 15,4 |
|   | HST-R   | [kN] | 5,8                  | 4,9  | 5,9  | 8,8  | 22,8 | 27,5 | 2,8              | 3,5 | 4,2 | 5,1  | 10,7 | 15,4 |
|   | HST-HCR   | [kN] | 5,8                  | 5,6  | 5,9  | 8,8  | -    | -    | 2,8              | 3,5 | 4,2 | 5,1  | -    | -    |

#### Double anchor, no edge effects, min. spacing ( $s = s_{min}$ ), (load values are valid for one anchor)

| Anchor size                                 |   |      | Non-cracked concrete |      |      |      |      |      | Cracked concrete |      |      |      |      |      |
|---|---|------|----------------------|------|------|------|------|------|------------------|------|------|------|------|------|
|   |   |      | M8                   | M10  | M12  | M16  | M20  | M24  | M8               | M10  | M12  | M16  | M20  | M24  |
| Min. base material thickness $h_{min}$ [mm] |   |      | 100                  | 120  | 140  | 160  | 200  | 250  | 100              | 120  | 140  | 160  | 200  | 250  |
| Min. spacing $s_{min}$ [mm]                 |   |      | 60                   | 55   | 60   | 70   | 100  | 125  | 40               | 55   | 60   | 70   | 100  | 125  |
|   | <b>Tensile <math>N_{Rd}</math></b>                  |      |                      |      |      |      |      |      |                  |      |      |      |      |      |
|   | HST   | [kN] | 5,0                  | 10,2 | 12,7 | 16,0 | 22,7 | 31,3 | 2,8              | 6,0  | 8,0  | 11,4 | 16,2 | 22,4 |
|   | HST-R   | [kN] | 6,0                  | 10,2 | 12,7 | 16,0 | 22,7 | 31,3 | 3,3              | 6,0  | 8,0  | 11,4 | 16,2 | 22,4 |
|   | HST-HCR   | [kN] | 6,0                  | 10,2 | 12,7 | 16,0 | -    | -    | 3,3              | 6,0  | 8,0  | 11,4 | -    | -    |
|   | <b>Shear <math>V_{Rd}</math>, without lever arm</b> |      |                      |      |      |      |      |      |                  |      |      |      |      |      |
|   | HST   | [kN] | 11,2                 | 18,8 | 27,8 | 40,1 | 56,7 | 62,7 | 8,3              | 14,6 | 19,9 | 22,9 | 40,5 | 55,9 |
|   | HST-R   | [kN] | 10,4                 | 16,0 | 24,0 | 38,5 | 55,6 | 78,4 | 9,9              | 14,6 | 19,9 | 28,6 | 40,5 | 55,9 |
|   | HST-HCR   | [kN] | 10,4                 | 16,0 | 24,0 | 40,1 | -    | -    | 9,9              | 14,6 | 19,9 | 28,6 | -    | -    |