DIVISION: 03 00 00—CONCRETE
SECTION: 03 15 19—CAST-IN CONCRETE ANCHORS
SECTION: 03 16 00—CONCRETE ANCHORS

REPORT HOLDER:
HALFEN GMBH
LIEBIGSTRASSE 14
40764 LANGENFELD
GERMANY

EVALUATION SUBJECT:
HALFEN HZA ANCHOR CHANNELS AND HZS CHANNEL BOLTS

“2014 Recipient of Prestigious Western States Seismic Policy Council (WSSPC) Award in Excellence”

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1.0 EVALUATION SCOPE
Compliance with the following codes:
- 2013 *Abu Dhabi International Building Code* (ADIBC)†

†The ADIBC is based on the 2009 IBC, code sections referenced in this report are the same sections in the ADIBC.

Properties evaluated:
Structural

2.0 USES
HALFEN HZA anchor channels and HALFEN HZS channel bolts are used as anchorage in concrete to resist static, wind, and seismic (IBC Seismic Design Categories A through F) tension loads (N_{w}), shear loads perpendicular to the longitudinal channel axis (V_{x,y}), and shear loads longitudinal to the channel axis (V_{z,z}), or any combination of these loads (as illustrated in Figure 1) applied at any location between the outermost anchors of the anchor channel.

The use is limited to cracked or uncracked normal-weight concrete having a specified compressive strength, f'_c, of 2,500 psi to 10,000 psi (17.2 MPa to 69.0 MPa) [minimum of 24 MPa is required under ADIBC Appendix L, Section 5.1.1]. The anchor channels are an alternative to anchors described in Section 1901.3 of the 2015 IBC, Sections 1908 and 1909 of the 2012 IBC and Sections 1911 and 1912 of the 2009 and 2006 IBC. The anchor channels may also be used where an engineered design is submitted in accordance with Section R301.1.3 of the IRC.

3.0 DESCRIPTION
3.1 Product information:
The HZA anchor channels (HZA 38/23 and 53/34) consist of a C-shaped steel channel profile with serrated (toothed) channel lips with I-shaped steel anchors or T-shaped steel anchors. I- and T-shaped anchors are factory welded to the channel back (as illustrated in Figure B of this report). The maximum number of anchors per channel is not limited. The HALFEN HZA anchor channels are made of carbon steel channel profiles. The anchor channels are shown in Figure A of this report. The available channel bolts feature a hammer-head and are shown in Figure C. The combination of the HALFEN HZA anchor channels and the corresponding HZS channel bolts covered by this report are described in Table 2 of this report. The appropriate channel bolts shall be placed in the anchor channel.
3.2 Material information:
Steel specifications for the channel profiles, anchors and channel bolts are given in Table 9 of this report.

3.3 Concrete:
Normal-weight concrete shall comply with Sections 1903 and 1905 of the IBC.

4.0 DESIGN AND INSTALLATION

4.1 General:
The design strength of anchor channels under the 2015, 2012, 2009, and 2006 IBC, must be determined in accordance with ACI 318-14 chapter 17, ACI 318-11, -08, and -05 Appendix D, as applicable, and this report.

4.1.1 Determination of forces acting on anchor channel: Anchor channels shall be designed for critical effects of factored loads as determined by elastic analysis taking into account the elastic support by anchors and the partial restraint of the channel ends by concrete compression stresses. As an alternative, the triangular load distribution method in accordance with Section 4.1.2 through 4.1.4 to calculate the tension and shear loads on anchors shall be permitted.

4.1.2 Tension loads: The tensile loads, $N_{a,x,i}$ on an anchor due to a tension load, $N_{a}$, acting on the channel shall be computed in accordance with Eq. (D-0.a). An example for the calculation of the tension loads acting on the anchor is given in Figure 2.

$$N_{a,x,i} = k \cdot A'_i \cdot N_{a}$$

(D-0.a)

where

$A'_i$ = ordinate at the position of the anchor $i$ assuming a triangle with the unit height at the position of load $N_{a}$ and the base length 2 $l_n$ with $l_n$ determined in accordance with Eq. (D-0.c). An example is provided in Figure 2.

$$k = 1/\Sigma A'_i$$

(D-0.b)

$$\lambda_{in} = 4.93 \cdot (I_y)^{0.05} \cdot \sqrt{s} \geq s, \text{ in.}$$

(D-0.c)

$$\lambda_{in} = 13 \cdot (I_y)^{0.05} \cdot \sqrt{s} \geq s, \text{ mm}$$

(D-0.c)

$s$ = anchor spacing, in. (mm)

$N_{a}$ = factored tension load on anchor channel, lbf (N)

$I_y$ = the moment of inertia of the channel shall be taken from Table 1 of this report.

If several tension loads are simultaneously acting on the channel, a linear superimposition of the anchor forces for all loads shall be assumed.

If the exact position of the load on the channel is not known, the most unfavorable loading position shall be assumed for each failure mode (e.g. load acting over an anchor for the case of failure of an anchor by steel rupture or pull-out and load acting between anchors in the case of bending failure of the channel).

4.1.3 Bending moment: The bending moment $M_{b,flex}$ on the channel due to tension loads acting on the channel shall be computed assuming a simply supported single span beam with a span length equal to the anchor spacing.

4.1.4 Shear loads:

4.1.4.1 Shear perpendicular to the channel axis: The shear load $V_{a,x,y}$ on an anchor due to a shear load $V_{a}$ acting on the channel perpendicular to its longitudinal axis shall be computed in accordance with Section 4.1.2 replacing $N_{a}$ in Eq. (D-0.a) by $V_{a,y}$.

4.1.4.2 Shear longitudinal to the channel axis: The shear load $V_{a,x,i}$ on an anchor due to a shear load $V_{a,x}$ acting on the channel in direction of the longitudinal channel axis shall be computed as follows:

For the verification of the strength of the anchor channel for failure of the anchor or failure of the connection between anchor and channel, pryout failure and concrete edge failure in case of anchor channels arranged parallel to the edge without corner effects, the shear load $V_{a,x}$ shall be equally distributed to all anchors for anchor channels with not more than three anchors or to three anchors for anchor channels with more than three anchors (as illustrated in Figure 3). The shear load $V_{a,x}$ shall be distributed to those three that result in the most unfavorable design condition (in the example given in Figure 3 the shear load $V_{a,x}$ shall be distributed to the anchors 10 to 12).

For verification of the strength of the anchor channel for concrete edge failure in case of anchor channels arranged perpendicular to the edge and in case of anchor channels arranged parallel to the edge with corner effects, the shear load $V_{a,x}$ shall be equally distributed to all anchors for anchor channels with not more than three anchors, or to the three anchors closest to the edge or corner for anchor channels with more than three anchors (as illustrated in Figure 4).
**FIGURE 3**—EXAMPLE FOR THE CALCULATION OF ANCHOR FORCES IN CASE OF ANCHOR CHANNELS WITH 12 ANCHORS LOADED IN SHEAR LONGITUDINAL TO THE CHANNEL AXIS FOR STEEL AND PRYOUT FAILURE

**FIGURE 4**—EXAMPLE FOR THE CALCULATION OF ANCHOR FORCES IN CASE OF ANCHOR CHANNELS WITH 6 ANCHORS LOADED IN SHEAR LONGITUDINAL TO THE CHANNEL AXIS FOR CONCRETE EDGE FAILURE

**4.2 Strength design:**

**4.2.1 General:** The design strength of anchor channels under the 2015 IBC as well as Section R301.1.3 of the 2015 IRC shall be determined in accordance with ACI 318-14 Chapter 17 and this report.

The design strength of anchor channels under the 2012 IBC, as well as Section R301.1.3 of the 2012 IRC, shall be determined in accordance with ACI 318-11 Appendix D and this report.

The design strength of anchor channels under the 2009 IBC, as well as Section R301.1.3 of the 2009 IRC, shall be determined in accordance with ACI 318-08 Appendix D and this report.

The design strength of anchor channels under the 2006 IBC, as well as Section R301.1.3 of the 2006 IRC shall be determined in accordance with ACI 318-05 Appendix D and this report.

Design parameters in this report and references to ACI 318 are based on the 2015 IBC (ACI 318-14) and the 2012 IBC (ACI 318-11) unless noted otherwise in Section 4.2.1 through 4.2.10 of this report.

The strength design shall comply with ACI 318-14 17.3.1 or ACI 318-11 D.4.1, as applicable, except as required in ACI 318-14 17.2.3 or ACI 318-11 D.3.3, as applicable.

Design parameters are provided in Tables 1 through 10 of this report. Strength reduction factors, φ, as given in the tables of this report shall be used for load combinations calculated in accordance with Section 1605.2.1 of the IBC, Section 5.3 of ACI 318-14, or Section 9.2 of ACI 318-11, as applicable.

In Eq. (D-1), and (D-2) (ACI 318-05, -08), Table D.4.1.1 (ACI 318-11) or Table 17.3.1.1 (ACI 318-14) φNc and φVn are the lowest design strengths determined from all appropriate failure modes. φNc is the lowest design strength in tension of an anchor channel determined from consideration of φNB, φNCC, φNBCC, φNCCS, φMMR, φNB, (anchor channels without anchor reinforcement to take up tension loads) or φNca (anchor channels with anchor reinforcement to take up tension loads), φVn, and φNbs.
\(\phi V_{n,y}\) is the lowest design strength in shear perpendicular to the axis of an anchor channel as determined from \(\phi V_{a,y}\), \(\phi V_{sc,y}\), \(\phi V_{sa,y}\), \(\phi V_{cb,y}\),(anchor channels without anchor reinforcement to take up shear loads perpendicular to the channel axis), or \(\phi V_{c,y}\) (anchor channels with anchor reinforcement to take up shear loads perpendicular to the channel axis) and \(\phi V_{c,x}\) is the lowest design strength in shear acting longitudinal to the channel axis of an anchor channel as determined from \(\phi V_{a,x}\), \(\phi V_{sc,x}\), \(\phi V_{sa,x}\), \(\phi V_{cb,x}\), (anchor channel without anchor reinforcement to take up shear loads), or \(\phi V_{c,x}\) (anchor channel with anchor reinforcement to take up shear loads) and \(\phi V_{c,x}\). The design strength for all anchors of an anchor channel shall be determined.

### 4.2.2 Tension loads:

#### 4.2.2.1 General:
Following verifications are required:

a) Steel failure: Steel strength of anchor, strength of connection between anchor and channel, strength for local failure of channel lip, strength of channel bolt, bending strength of channel, see Section 4.2.2.2.

b) Concrete breakout strength of anchor in tension, see Section 4.2.2.3.

c) Pullout strength of anchor channel in tension, see Section 4.2.2.4.

d) Concrete side-face blow-out strength of anchor channels in tension, see Section 4.2.2.5.

#### 4.2.2.2 Steel strength in tension:

The nominal strength, \(N_{sa}\), of a single anchor shall be taken from Table 3 of this report.

The nominal strength, \(N_{sc}\), of the connection between anchor and channel shall be taken from Table 3 of this report.

The nominal strength of the channel lips to take up tension loads transmitted by a channel bolt, \(N_{sl}\), shall be taken from Table 3 of this report. This value is valid only if the center-to-center distance between the channel bolts under consideration and adjacent channel bolts, \(s_{cb}\), is at least 2\(b_{ch}\). If this requirement is not met, then the value \(N_{sl}\) given in Table 3 shall be reduced by the factor:

\[
1 + \sum_{i=1}^{n} \left( \frac{s_{cb,i}}{2b_{ch}} \right)^{2} \frac{N_{sa,i}^{0}}{N_{sa,i}^{1}}
\]

where the center-to-center spacing between channel bolts shall not be less than 3-times the bolt diameter, \(d_{b}\).

\(b_{ch}\) = channel width, taken from Table 1, in. (mm)

The nominal strength of the channel bolt, \(N_{sb}\), shall be taken from Table 7 of this report.

The nominal bending strength of the anchor channel, \(M_{b, flex}\), shall be taken from Table 3 of this report.

#### 4.2.2.3 Concrete breakout strength in tension:

The nominal concrete breakout strength, \(N_{sb}\), of a single anchor in tension of an anchor channel shall be determined in accordance with Eq. (D-4.a).

\[
N_{sb} = N_{b} \cdot \psi_{c,h} \cdot \psi_{ad,n} \cdot \psi_{co,n} \cdot \psi_{c,p,n} \cdot \psi_{cp,n} \cdot \phi_{sa,y} \text{ lbf (N)}
\]

The basic concrete breakout strength of a single anchor in tension in cracked concrete, \(N_{sb}\), shall be determined in accordance with Eq. (D-7.a).

\[
N_{sb} = 24 \cdot \lambda \cdot (\phi_{sa,y})^{0.5} \cdot h_{ef}^{1.5} \text{ lbf (N)} \tag{D-7.a}
\]

\[
N_{sb} = 10 \cdot \lambda \cdot (\phi_{sa,y})^{0.5} \cdot h_{ef}^{1.5} \text{ N} \tag{D-7.a}
\]

where

\[
\lambda = 1 \quad \text{(normal-weight concrete)}
\]

\[
a_{ch,N} = \left( \frac{h_{ef}}{7.1} \right)^{0.15} \leq 1.0, \text{ (inch-pound units)} \tag{D-7.b}
\]

\[
a_{ch,N} = \left( \frac{h_{ef}}{180} \right)^{0.15} \leq 1.0, \text{ (SI-units)} \tag{D-7.b}
\]

The modification factor to account for the influence of location and loading of adjacent anchors, \(\psi_{s,N}\), shall be computed in accordance with Eq. (D-9.a)

\[
\psi_{s,N} = \frac{1}{1 + \sum_{i=1}^{n-1} \left( 1 - \frac{s_{i}}{s_{cr,N}} \right)^{1.5} \frac{N_{sa,i}^{0}}{N_{sa,i}^{1}}} \tag{D-9.a}
\]

where (as illustrated in Figure 6):

\[
s_{i} = \text{ distance between the anchor under consideration and adjacent anchor, in. (mm)}
\]

\[
s_{cr,N} \geq 2 \left( 2.8 - (1.3 \ h_{ef}/7.1) \right) \ h_{ef} \ \geq 3 \ h_{ef}, \text{ in.} \tag{D-9.b}
\]

\[
s_{cr,N} \geq 2 \left( 2.8 - (1.3 \ h_{ef}/180) \right) \ h_{ef} \ \geq 3 \ h_{ef}, \text{ mm} \tag{D-9.b}
\]

\[
N_{ua,i}^{0} = \text{ factored tension load of an influencing anchor, lbf (N)}
\]

\[
N_{ua,i}^{1} = \text{ factored tension load of the anchor under consideration, lbf (N)}
\]

\[
n = \text{ number of anchors within a distance } s_{cr,N} \text{ to both sides of the anchor under consideration}
\]

**FIGURE 6—EXAMPLE OF ANCHOR CHANNEL WITH NON-UNIFORM ANCHOR TENSION FORCES**

The modification factor for edge effect of anchors loaded in tension, \(\psi_{ad,N}\), shall be computed in accordance with Eq. (D-10.a) or (D-10.b).

If \(c_{a1} \geq c_{cr,N}\)

then \(\psi_{ad,N} = 1.0 \tag{(D-10.a)}\)

If \(c_{a1} \leq c_{cr,N}\)

then \(\psi_{ad,N} = \left( c_{a1} / c_{cr,N} \right)^{0.5} \leq 1.0 \tag{(D-10.b)}\)

where

\[
c_{cr,N} = 0.5 s_{cr,N}
\]

\[
= (2.8 - (1.3 \ h_{ef}/7.1)) \ h_{ef} \ \geq 1.5 \ h_{ef}, \text{ in.} \tag{D-11.a}
\]

\[
c_{cr,N} = 0.5 s_{cr,N}
\]

\[
= (2.8 - (1.3 \ h_{ef}/180)) \ h_{ef} \ \geq 1.5 \ h_{ef}, \text{ mm} \tag{D-11.a}
\]

If anchor channels are located in a narrow concrete member with multiple edge distances \(c_{a1,1}\) and \(c_{a1,2}\) (as shown in Figure 7b), the minimum value of \(c_{a1,1}\) and \(c_{a1,2}\) shall be inserted in Eq. (D-10.b).
For anchor channels located in a region of a concrete member where analysis indicates no cracking at service load levels, the following modification factor shall be permitted:

\[ \psi_{c,N} = 1.25. \]

Where analysis indicates cracking at service load levels, \( \psi_{c,N} \) shall be taken as 1.0. The cracking in the concrete shall be controlled by flexural reinforcement distributed in accordance with ACI 318-11, -08, -05 Section 10.6.4, or with ACI 318-14 Section 24.3.2 and 24.3.3, or equivalent crack control shall be provided by confining reinforcement.

The modification factor for anchor channels designed for uncracked concrete without supplementary reinforcement to control to control splitting, \( \psi_{cp,N} \), shall be computed in accordance with Eq. (D-12.a) or (D-13.a). The critical edge distance, \( c_{ac} \), shall be taken from Table 4 of this report.

If \( c_{a,min} \geq c_{ac} \)

then \( \psi_{cp,N} = 1.0 \) \hspace{1cm} (D-12.a)

If \( c_{a,min} < c_{ac} \)

then \( \psi_{cp,N} = c_{a,min} / c_{ac} \) \hspace{1cm} (D-13.a)

where \( \psi_{cp,N} \) as determined in accordance with Eq. (D-13.a) shall not be taken less than \( c_{ac} / c_{cr,N} \) with \( c_{cr,N} \) taken from Eq. (D-11.a). For all other cases, \( \psi_{cp,N} \) shall be taken as 1.0.

Where anchor reinforcement is developed in accordance with ACI 318-11 Chapter 12 or ACI 318-14 Chapter 25 on both sides of the breakout surface for an anchor of an anchor channel, the design strength of the anchor reinforcement, \( \phi N_{ca} \), shall be permitted to be used instead of the concrete breakout strength, \( \phi N_{cb} \), in determining \( \phi N_{c} \). The anchor reinforcement for one anchor shall be designed for the tension force, \( N_{u,as} \) on this anchor using a strut-and-tie model. The provisions in Figure 9 shall be taken into account when sizing and detailing the anchor reinforcement. Anchor reinforcement shall consist of stirrups made from deformed reinforcing bars with a maximum diameter of \( 5/8 \) in. (No. 5 bar) (16 mm). A strength reduction factor \( \phi \) of 0.75 shall be used in the design of the anchor reinforcement.

For anchor channels located parallel to the edge of a concrete member or in a narrow concrete member, the plane of the anchor reinforcement shall be arranged perpendicular to the longitudinal axis of the channel (as shown in Figure 9 a, b).
\[ M_{ss} = M_{ss}^0 \left( 1 - \frac{N_{ss}}{N_{ss}^0} \right), \text{ lb}-\text{in. (Nm)} \] (D-20.c)

\[ M_{ss}^0 = \text{nominal flexural strength of channel bolt. It shall be taken from Table 8 of this report} \]

\[ \leq 0.5 \cdot N_{ss}/a \]

\[ \leq 0.5 \cdot N_{ss}/a \]

\[ l = \text{lever arm, in. (mm)} \]

\[ a = \text{internal lever arm, in. (mm)} \]

The nominal strength of the channel lips to take up shear loads perpendicular to the channel axis transmitted by a channel bolt, \( V_{ss,y} \), shall be taken from Table 5 of this report.

The nominal strength of one anchor, \( V_{ss,y} \), to take up shear loads perpendicular to the channel axis shall be taken from Table 5 of this report.

The nominal strength of the connection between one anchor and the channel anchor, \( V_{ss,y} \), to take up shear loads perpendicular to the channel axis shall be taken from Table 5 of this report.

4.2.3.3 Concrete breakout strength of an anchor channel in shear perpendicular to the channel axis:
The nominal concrete breakout strength, \( V_{cb,y} \), in shear perpendicular to the channel axis of a single anchor of an anchor channel in cracked concrete shall be computed as follows:

a) For a shear force perpendicular to the edge, by Eq. (D-21.a)

\[ V_{cb,y} = V_b \cdot \psi_{c,y} \cdot \psi_{c,0,y} \cdot \psi_{c,v} \cdot \psi_{h,v}, \text{ lb} \] (N) (D-21.a)

b) For a shear force parallel to an edge (as shown in Figure 10), \( V_{cb,y} \), shall be permitted to be 2.5 times the value of the shear force determined from Eq. (D-21.a) with the shear force assumed to act perpendicular to the edge.

The basic concrete breakout strength in shear perpendicular to the channel axis of a single anchor of an anchor channel in cracked concrete, \( V_b \), shall be computed in accordance with Eq. (D-24.a).

\[ V_b = \lambda \cdot \alpha_{ch} \cdot \left( f'_c \right)^{0.5} \cdot c_{at}^{4/3}, \text{ lb} \] (N) (D-24.a)
where
\[ \lambda = 1 \text{ (normal-weight concrete)} \]
\[ \alpha_{ch,V} \] shall be taken from Table 6 of this report.
\[ f_c' = \text{the lesser of the specified concrete compressive strength and 8,500 psi (58.6 MPa)} \]

The modification factor to account for the influence of location and loading of adjacent anchors, \( \psi_{s,V} \) shall be computed in accordance with Eq. (D-24.b).

\[
\psi_{s,V} = \frac{1}{1 + \sum_{j=2}^{n} \left( 1 - \frac{s_{cr,j}}{s_{cr,V}} \right) \frac{V_{in,j}}{V_{in,Y}}} \tag{D-24.b}
\]

where (as illustrated in Figure 11):
\[ s_c = \text{distance between the anchor under consideration and the adjacent anchor, in. (mm)} \]
\[ \leq s_{cr,V} \]
\[ s_{cr,V} = 4c_{d1} + 2b_{ch}, \text{ in. (mm)} \tag{D-24.c} \]
\[ V_{in,j} = \text{factored shear load of an influencing anchor, lbf (N),} \]
\[ V_{in,Y} = \text{factored shear load of the anchor under consideration, lbf (N),} \]
\[ n = \text{number of anchors within a distance } s_{cr,V} \text{ to both sides of the anchor under consideration} \]

If \( c_{d2} \geq c_{cr,V} \), then \( \psi_{cr,V} = 1.0 \) \tag{D-24.d}

If \( c_{d2} < c_{cr,V} \), then \( \psi_{cr,V} = (c_{d2} / c_{cr,V})^{0.5} \) \tag{D-24.e}

where
\[ c_{cr,V} = 2c_{d1} + b_{ch}, \text{ in. (mm)} \tag{D-24.f} \]

The modification factor for corner effect for an anchor loaded in shear perpendicular to the channel axis (as shown in Figure 12a), \( \psi_{co,V} \) shall be computed in accordance with Eq. (D-24.a). \[ \psi_{co,V} = \frac{1}{1 + \sum_{j=2}^{n} \left( 1 - \frac{s_{cr,j}}{s_{cr,V}} \right) \frac{V_{in,j}}{V_{in,Y}}} \tag{D-24.a} \]

For anchor channels located in a region of a concrete member where analysis indicates no cracking at service load levels, the following modification factor shall be permitted:
\[ \psi_{cr,V} = 1.4. \]

For anchor channels located in a region of a concrete member where analysis indicates cracking at service load levels, the following modifications shall be permitted:
\[ \psi_{cr,V} = 1.0 \]

\[ \psi_{cr,V} = 1.2 \]

\[ \psi_{cr,V} = 1.4 \]

For anchor channels in cracked concrete containing edge reinforcement with a diameter of \( \frac{1}{2} \) inch (12.7 mm) or greater (No. 4 bar or greater) between the anchor channel and the edge, and with the edge reinforcement enclosed within stirrups spaced at 4 inches (100 mm) maximum.

The modification factor for anchor channels located in a concrete member with \( h < h_{cr,V} \), \( \psi_{h,V} \) (an example is given in Figure 13), shall be computed in accordance with Eq. (D-29.a).
\[ \psi_{h,V} = (h / h_{cr,V})^{1/2} \leq 1.0 \tag{D-29.a} \]

where
\[ h_{cr,V} = 2c_{d1} + 2b_{ch}, \text{ in. (mm)} \tag{D-29.b} \]
Where an anchor channel is located in a narrow member ($c_{a2,max} < c_{x,y}$) with a thickness $h < h_{cr,v}$ (see Figure 14), the edge distance $c_{a1}$ in Eq. (D-24.a), (D-24.c), (D-24.f) and (D-29.b) shall not exceed the value $c_{a1,red}$ determined in accordance with Eq. (D-29.c).

$$c_{a1,red} = \max \left[ \frac{c_{a,\text{max}}}{2}, \frac{h - 2h_{ch}}{2} \right], \text{ in. (mm)} \quad \text{(D-29.c)}$$

where $c_{a,\text{max}}$ is the largest of the edge distances perpendicular to the longitudinal axis of the channel.

For this example, the value of $c_{a1,red}$ is obtained by moving the failure surface forward until it intersects the corner as shown.

![FIGURE 14—EXAMPLE OF AN ANCHOR CHANNEL INFLUENCED BY TWO CORNERS AND MEMBER THICKNESS (IN THIS EXAMPLE $c_{a2,1}$ IS DECISIVE FOR THE DETERMINATION OF $c_{a1,red}$)](image)

A strength reduction factor of 0.75 shall be used in the design of the anchor reinforcement. The strength of the anchor reinforcement assumed in design shall not exceed the value in accordance with Eq. (D-29.d). Only anchor reinforcement that complies with Figure 15 shall be assumed as effective.

The maximum strength of the anchor reinforcement $V_{ca,y,max}$ of a single anchor of an anchor channel shall be computed in accordance with Eq. (D-29.d).

$$V_{ca,y,max} = \frac{2.85}{(c_{a1})^{0.12}} \cdot V_{cb,y}, \text{ lbf} \quad \text{(D-29.d)}$$

$$V_{ca,y,max} = \frac{4.20}{(c_{a1})^{0.12}} \cdot V_{cb,y}, \text{ N} \quad \text{(D-29.d)}$$

where $V_{cb,y}$ is determined in accordance with Eq. (D-21.a).

Anchor reinforcement shall consist of stirrups made from deformed reinforcing steel bars with a maximum diameter of $\frac{5}{8}$ in. (16 mm) (No. 5 bar) and straight edge reinforcement with a diameter not smaller than the diameter of the stirrups (as shown in Figure 15). Only one bar at both sides of each anchor shall be assumed as effective. The distance of this bar from the anchor shall not exceed 0.5$c_{a1}$ and the anchorage length in the breakout body shall not less than 4 times the bar diameter. The distance between stirrups shall not exceed the smaller of anchor spacing or 6 in. (152 mm).

![FIGURE 15—REQUIREMENTS FOR DETAILEDING OF ANCHOR REINFORCEMENT OF ANCHOR CHANNELS](image)

The anchor reinforcement of an anchor channel shall be designed for the highest anchor load, $V_{ua,y}$ of all anchors but at least for the highest individual shear load, $V_{ua,y}$ acting on the channel. This anchor reinforcement shall be arranged at all anchors of an anchor channel.

4.2.3.4 Concrete pryout strength of anchor channels in shear perpendicular to the channel axis: The nominal pryout strength, $V_{cp}$, in shear of a single anchor of an anchor channel without anchor reinforcement shall be computed in accordance with Eq. (D-30.a).

$$V_{cp} = V_{cp,x} = V_{cp,y} = k_{cp} N_{cb}, \text{ lbf (N)} \quad \text{(D-30.a)}$$

where

$k_{cp}$ = factor taken from Table 6 of this report

$N_{cb}$ = nominal concrete breakout strength of the anchor under consideration, lbf (N), determined in accordance with 4.2.2.3; however in the determination of the modification factor $\psi_{a,N}$, the values $N_{ua,1}$ and $N_{ua,y}$ in Eq. (D-9.a) shall be replaced by $V_{ua,1}^{\text{N}}$ and $V_{ua,y}^{\text{N}}$, respectively.

The nominal pryout strength, $V_{cp}$, in shear of a single anchor of an anchor channel with anchor reinforcement shall not exceed.

$$V_{cp} = V_{cp,x} = V_{cp,y} = 0.75 \cdot k_{cp} \cdot N_{cb}, \text{ lbf (N)} \quad \text{(D-31.a)}$$

where $k_{cp}$ and $N_{cb}$ as defined above.

4.2.4 Shear loads acting longitudinal to the channel axis:

4.2.4.1 General: Following verifications are required:

a) Steel failure: Strength of channel bolt, strength for local failure of channel lip, strength of connection between anchor and channel profile and strength of anchor, see Section 4.2.4.2.
b) Concrete edge breakout strength of anchor channel in shear, see Section 4.2.4.3.

c) Concrete pryout strength of anchor channel in shear, see Section 4.2.4.4.

4.2.4.2 Steel strength of anchor channels in shear: For anchor channels, the nominal steel shear strength shall be determined as follows:

The nominal strength of a channel bolt in shear, \( V_{ss} \), shall be taken from Table 8 of this report.

If the fixture is not clamped against the concrete but secured to the channel bolt at a distance from the concrete surface (e.g. by double nuts), the nominal strength of a channel bolt in shear, \( V_{ss,M} \), shall be computed in accordance with Eq. (D-20.b).

The nominal strength of the channel lips to take up shear loads in direction of the longitudinal channel axis transmitted by a channel bolt, \( V_{cl,x} \), shall be taken from Table 5 of this report.

The nominal strength of one anchor, \( V_{sa,x} \), to take up shear loads perpendicular to the channel axis shall be taken from Table 5 of this report.

The nominal strength of the connection between one anchor and the anchor channel, \( V_{sc,x} \), to take up shear loads longitudinal to the channel axis shall be taken from Table 5 of this report.

4.2.4.3 Concrete breakout strength of an anchor channel in shear: The nominal concrete breakout strength, \( V_{cb,x} \), in shear in direction of the longitudinal channel axis of a single anchor of an anchor channel in cracked concrete shall be computed as follows:

a) For a shear force perpendicular to the edge, by Eq. (D-21.a). The basic concrete breakout strength in shear in direction of the longitudinal channel axis of a single anchor of an anchor channel in cracked concrete, \( V_{c,x} \), shall be computed in accordance with Eq. (D-24.a).

b) For a shear force parallel to an edge, \( V_{cp,x} \), shall be permitted to be 2 times the value of the shear force determined from Eq. (D-21.a) with the shear force assumed to act perpendicular to the edge.

4.2.4.4 Concrete pryout strength in shear: The nominal pryout strength, \( V_{cp,x} \), in shear in direction of the longitudinal channel axis of a single anchor of an anchor channel with anchor reinforcement shall not exceed Eq. (D-31.a).

4.2.5 Requirements for seismic design: Anchor channels shall be designed according to D.3.3.5 (ACI 318-05) or 17.2.3.5.3 (ACI 318-14).

The design of channels to resist tension loads in SDC C, D, E or F where D.3.3.4.2 (ACI 318-11) or 17.3.3.4.2 (ACI 318-14) applies shall satisfy the requirements of D.3.3.4.3. (b), (c) or (d) (ACI 318-11) or 17.3.2.3.4.3 (b), (c) or (d) (ACI 318-14), as applicable. The design of anchor channels to resist shear loads in SDC C, D, E or F where D.3.3.5.2 (ACI 318-11) or 17.3.3.5.2 (ACI 318-14) applies shall satisfy the requirements of D.3.3.5.3. (ACI 318-11) or 17.2.3.5.3 (ACI 318-14).

For anchor channels in SDC C, D, E or F the design strengths given in Section 4.2.1 through Section 4.2.4 shall be taken as the corresponding seismic strengths \( \phi V_{n,seis} \), \( \phi V_{y,seis} \) and \( \phi V_{n,x,seis} \).

4.2.6 Interaction of tensile and shear forces: For designs that include combined tensile and shear forces, the interaction of these loads has to be verified.

Anchor channels subjected to combined axial and shear loads shall be designed to satisfy the following requirements by distinguishing between steel failure of the channel bolt, steel failure modes of the anchor channel and concrete failure modes.

4.2.6.1 Steel failure of channel bolts under combined loads: For channel bolts, Eq. (D-32.a) shall be satisfied

\[
\left( \frac{N_{sa}^a}{\phi N_{sa}} \right)^2 + \left( \frac{V_{sa}^b}{\phi V_{sa}} \right)^2 \leq 1.0 \quad (D-32.a)
\]

with \( V_{sa}^b = \sqrt{V_{sa,x}^b + V_{sa,y}^b} \)

where \( N_{sa}^a \) is the factored tension load, \( V_{sa,y}^b \) is the factor shear load in perpendicular direction, and \( V_{sa,x}^b \) is the factored shear load in longitudinal direction to the channel axis on the channel bolt under consideration.

This verification is not required in case of shear load with lever arm as Eq. (D-20.b) accounts for the interaction.

4.2.6.2 Steel failure modes of anchor channels under combined loads: For steel failure modes of anchor channels Eq. (D-32.b), (D-32.c) and (D-32.d) shall be satisfied.

a) For anchor and connection between anchor and channel profile:

\[
\max \left( \frac{N_{sa}^a}{\phi N_{sa}} ; \frac{N_{sa}^c}{\phi N_{sc}} \right)^a + \max \left( \frac{V_{sa,x}^b}{\phi V_{sa,x}} ; \frac{V_{sa,y}^b}{\phi V_{sa,y}} \right)^a \leq 1 - \max \left( \frac{V_{sa,x}^a}{\phi V_{sa,x}} ; \frac{V_{sa,y}^a}{\phi V_{sa,y}} \right)^a \quad (D-32.b)
\]

where

\( \alpha = 1 \) for anchor channels to resist tension and shear loads in SDC C, D, E or F

In all other cases:

\( \alpha = 2 \) for anchor channels with

\[
\max (V_{sa,y}^a; V_{sc,y}^a) \leq \min (N_{sa}, N_{sc})
\]

\( \alpha = 1 \) for anchor channels with

\[
\max (V_{sa,y}^a; V_{sc,y}^a) > \min (N_{sa}, N_{sc})
\]

It shall be permitted to assume reduced values for \( V_{sa,y}^a \) and \( V_{sc,y}^a \) corresponding to the use of an exponent \( \alpha = 2 \). In this case the reduced values for \( V_{sa,y}^a \) and \( V_{sc,y}^a \) shall also be used in Section 4.2.3.1a).

b) At the point of load application:

\[
\left( \frac{N_{sa}^a}{\phi N_{sa}} \right)^a + \left( \frac{V_{sa,y}^b}{\phi V_{sa,y}} \right)^a \leq 1.0 \left( \frac{V_{sa,x}^b}{\phi V_{sa,x}} \right)^a \quad (D-32.c)
\]

\[
\left( \frac{M_{l,flex}^a}{\phi M_{l,flex}} \right)^a + \left( \frac{V_{sa,y}^b}{\phi V_{sa,y}} \right)^a \leq 1.0 \left( \frac{V_{sa,x}^b}{\phi V_{sa,x}} \right)^a \quad (D-32.d)
\]

where

\( \alpha = 1 \) for anchor channels to resist tension and shear loads in SDC C, D, E or F
In all other cases:
\[\sigma = 2 \text{ for anchor channels with } V_{a,y} \leq N_{a,y},\]
\[\sigma = 1 \text{ for anchor channels with } V_{a,y} > N_{a,y}.\]

4.2.6.3 Concrete failure modes of anchor channels under combined loads: For concrete failure modes of anchor channels Eq. (D-32.e) shall be satisfied.

\[
\left(\frac{N_{a}}{N_{inc}}\right)^{\alpha} + \left(\frac{V_{a,x}}{V_{inc,x}}\right)^{\alpha} + \left(\frac{V_{a,y}}{V_{inc,y}}\right)^{\alpha} \leq 1.0 \tag{D-32.e}
\]

where
\[\alpha = 1 \text{ for anchor channels to resist tension and shear loads in SDC C, D, E or F.}\]

In all other cases:
\[\alpha = 1.5 \text{ for anchor channels without anchor reinforcement or with anchor reinforcement to take up tension and shear loads}\]
\[\alpha = 1 \text{ for anchor channels with anchor reinforcement to take up tension or shear loads}\]

4.2.7 Minimum member thickness, anchor spacing, and edge distance: Anchor channels shall satisfy the requirements for edge distance, anchor spacing, and member thickness.

The minimum edge distance, minimum and maximum anchor spacing, and minimum member thickness shall be taken from Table 1 of this report.

The critical edge distance, \(c_{nc}\), shall be taken from Table 4 of this report.

4.3 Allowable stress design:

4.3.1 General: Strength design values determined in accordance with ACI 318-05, -08, -11 Appendix D or ACI 318-14 Chapter 17, as applicable, with amendments in Section 4.2 of this report may be converted to values suitable for use with allowable stress design (ASD) load combinations. Such guidance of conversions shall be in accordance with the following:

For anchor channels designed using load combinations in accordance with IBC Section 1605.3 (Allowable Stress Design), allowable loads shall be established using Eq.(3.1), Eq.(3.2), or Eq.(3.3):

\[T_{allowable,ASD} = \phi N_n / \alpha_{ASD}\]  \tag{3.1}
\[V_{x,allowable,ASD} = \phi V_{n,x} / \alpha_{ASD}\]  \tag{3.2}
\[V_{y,allowable,ASD} = \phi V_{n,y} / \alpha_{ASD}\]  \tag{3.3}
\[M_{s,flex,allowable,ASD} = \phi M_{s,flex} / \alpha_{ASD}\]  \tag{3.4}

where:
\[T_{allowable,ASD} = \text{allowable tension load, lbf (N)}\]
\[V_{x,allowable,ASD} = \text{allowable shear load longitudinal to the channel axis, lbf (N)}\]
\[V_{y,allowable,ASD} = \text{allowable shear load perpendicular to the channel axis, lbf (N)}\]
\[M_{s,flex,allowable,ASD} = \text{allowable bending moment due to tension loads lbf-in. (Nm)}\]
\[\phi N_n = \text{lowest design strength of an anchor, channel bolt, or anchor channel in tension for controlling failure mode as determined in accordance with ACI 318-05, -08, -11 Appendix D or ACI 318-14 Chapter 17 as applicable with amendments in Section 4.2 of this report, lbf (N)}\]
\[\phi V_{n,x} = \text{lowest design strength of an anchor, channel bolt, or anchor channel in shear longitudinal to the channel axis for controlling failure mode as determined in accordance with ACI 318-05, -08, -11 Appendix D or ACI 318-14 Chapter 17 as applicable with amendments in Section 4.2 of this report, lbf (N)}\]

4.3.2 Interaction of tensile and shear forces: Interaction shall be calculated in accordance with Section 4.2.4 and amendments in Section 4.2.2 of this report.

\[N_{a}, V_{ia,x}, V_{ia,y} \text{ and } M_{ia,flex}\] shall be replaced by the unfactored loads \(T^a, V^a_x, V^a_y\), and \(M^a\). The design strengths \(\phi N_n, \phi V_{n,x}, \phi V_{n,y}\) and \(M_{s,flex}\) shall be replaced by the allowable loads \(T_{allowable,ASD}, V_{x,allowable,ASD}, V_{y,allowable,ASD} \text{ and } M_{s,flex,allowable,ASD}\) where:

\[T^a = \text{unfactored tension load applied to an anchor channel, lbf (N)}\]
\[M^a = \text{unfactored bending moment on anchor channel due to tension loads, lbf-in. (Nm)}\]
\[V^a_x = \text{unfactored shear load applied to an anchor channel longitudinal to the channel axis, lbf (N)}\]
\[V^a_y = \text{unfactored shear load applied to an anchor channel perpendicular to the channel axis, lbf (N)}\]

4.4 Installation:

Installation parameters are provided in Table 1 of this report. Anchor channel locations shall comply with this report and the plans and specifications approved by the building official. Installation of the anchor channels and channel bolts shall conform to the manufacturer’s printed installation instructions (MPII) included in each shipment, as provided in Table 10 and Figures D and E of this report.

4.5 Special inspection:

Periodic special inspection shall be performed except as noted in Table 5 of this report, continuous special inspection shall be performed in accordance with the strength reduction factor requirement as determined by the registered design professional. The registered design professional shall specify periodic or continuous special inspection in the contract documents.

Inspections shall be performed as required in accordance with Section 1705.1.1 and Table 1705.3 of the 2015 and 2012 IBC, Section 1704.15 of the 2009 IBC and Section 1704.13 of the 2006 IBC and in accordance with this report. For each type of anchor channel, the manufacturer shall provide inspection procedures to verify proper usage.

4.5.1 Inspection requirements: Prior to concrete placement, the special inspector shall inspect the placement of anchor channels in the formwork to verify anchor channel type, channel size, anchor type, number of anchors, anchor size, and length of anchors, as well as anchor channel location, position, orientation and edge distance in accordance with the construction documents. The special inspector shall also verify that anchor channels
are secured within the formwork in accordance with the manufacturer’s printed installation instructions (MPII).

Following placement of concrete and form removal, the special inspector shall verify that the concrete around the anchor channel is without significant visual defects, that the anchor channel is flush with the concrete surface, and that the channel interior is free of concrete, laitance, or other obstructions. When anchor channels are not flush with the concrete surface, the special inspector shall verify that appropriate sized shims are provided in accordance with the MPII. Following the installation of attachments to the anchor channel, the special inspector shall verify that the specified system hardware, such as T-headed channel bolts and washers, have been used and positioned correctly, and the installation torque has been applied to the channel bolts in accordance with the installation instruction (MPII).

The special inspector shall be present for the installations of attachments to each type and size of anchor channel.

Where they exceed the requirements stated here, the special inspector shall adhere to the special inspection requirements provided in the statement of special inspections as prepared by the registered design professional in responsible charge.

4.5.2 Proof loading program: Where required by the registered design professional in responsible charge, a program for on-site proof loading (proof loading program) to be conducted as part of the special inspection shall include at a minimum the following information:

1. Frequency and location of proof loading based on channel size and length;
2. Proof loads specified by channel size and channel bolt;
3. Acceptable displacements at proof load;
4. Remedial action in the event of failure to achieve proof load or excessive displacement.

5.0 CONDITIONS OF USE

The HALFEN HZA anchor channel and HZS channel bolts described in this report are a suitable alternative to what is specified in those codes listed in Section 1.0 of this report, subject to the following conditions:

5.1 The anchor channels and channel bolts are recognized for use to resist static short- and long-term loads, including wind and seismic loads (IBC seismic design categories A through F), subject to the conditions of this report.

5.2 The anchor channels and channel bolts shall be installed in accordance with the manufacturer’s printed installation instructions (MPII), as included in the shipment and as shown in Table 10 and Figures D and E of this report.

5.3 The anchor channels shall be installed in cracked or uncracked normal-weight concrete having a specified compressive strength $f_c = 2,500$ psi to $10,000$ psi (17.2 MPa to 69.0 MPa) [minimum of 24 MPa is required under ADIBC Appendix L, Section 5.1.1].

5.4 The use of anchor channels in lightweight concrete is beyond the scope of this evaluation report.

5.5 Strength design values shall be established in accordance with Section 4.2 of this report.

5.6 Allowable stress design values are established with Section 4.3 of this report.

5.7 Minimum and maximum anchor spacing and minimum edge distance as well as minimum member thickness shall comply with the values given in this report.

5.8 Prior to anchor channel installation, calculations and details demonstrating compliance with this report shall be submitted to the code official. The calculations and details shall be prepared by a registered design professional where required by the statutes of the jurisdiction in which the project is to be constructed.

5.9 Where not otherwise prohibited by the code, HALFEN HZA anchor channels are permitted for use with fire-resistance-rated construction provided that at least one of the following conditions is fulfilled:

- Anchor channels are used to resist wind or seismic forces only (IBC seismic design categories A through F).
- Anchor channels that support a fire-resistance-rated envelope or a fire-resistance-rated membrane are protected by approved fire-resistance-rated materials, or have been evaluated for resistance to fire exposure in accordance with recognized standards.
- Anchor channels are used to support nonstructural elements.

5.10 Since an acceptance criteria for evaluating data to determine the performance of anchor channels subjected to fatigue or shock loading is unavailable at this time, the use of these anchor channels under such conditions is beyond the scope of this report.

5.11 Use of hot-dip galvanized carbon steel anchor channels is permitted for exterior exposure or damp environments.

Steel anchoring materials in contact with preservative-treated and fire-retardant-treated wood shall be of zinc-coated carbon steel. The minimum coating weights for zinc-coated steel shall comply with ASTM A153.

5.13 Special inspection shall be provided in accordance with Section 4.5 of this report.

5.14 HALFEN anchor channels and channel bolts are produced under an approved quality-control program with regular inspections performed by ICC-ES.

6.0 EVIDENCE SUBMITTED

6.1 Data in accordance with ICC-ES Acceptance Criteria for Anchor Channels in Concrete Elements (AC232), dated June 2017.

6.2 Quality-control documentation.

7.0 IDENTIFICATION

7.1 The anchor channels are identified by the manufacturer’s name, anchor channel type and size (e.g. HZA 53/34) embossed into the channel profile or printed on the channel profile. The marking is visible after installation of the anchor channel. The evaluation report number (ESR-4016) and ICC-ES mark will be stated on the accompanying documents.

7.2 The channel bolts are identified by packaging labeled with the manufacturer’s name, bolt type, bolt diameter and length, bolt grade, corrosion protection type (e.g. HZS 53/34 M16 x 60), evaluation report number (ESR-4016), and ICC-ES mark.
8.0 NOTATIONS

Equations are provided in units of inches and pounds. For convenience, SI (metric) units are provided in parentheses where appropriate. Unless otherwise noted, values in SI units shall be not used in equations without conversion to units of inches and pounds.

- \( b_{ch} \): width of channel, as shown in Figure 14, in. (mm)
- \( c_a \): edge distance of anchor channel, measured from edge of concrete member to axis of the nearest anchor as shown in Figure 14, in. (mm)
- \( c_{a1} \): edge distance of anchor channel in direction 1 as shown in Figure 14, in. (mm)
- \( c_{a1} \): net distance between edge of the concrete member and the anchor channel: \( c_{a1} = c_a - b_{ch}/2 \), in. (mm)
- \( c_{a,\text{red}} \): reduced edge distance of the anchor channel, as referenced in Eq. (D-29.c)
- \( c_{a2} \): edge distance of anchor channel in direction 2 as shown in Figure 14, in. (mm)
- \( c_{a,\text{max}} \): maximum edge distance of anchor channel, in. (mm)
- \( c_{a,\text{min}} \): minimum edge distance of anchor channel, in. (mm)
- \( c_{cr} \): edge distance required to develop full concrete capacity in absence of anchor reinforcement to control splitting, in. (mm)
- \( c_{cr,N} \): critical edge distance for anchor channel for tension loading for concrete breakout, in. (mm)
- \( c_{cr,Nb} \): critical edge distance for anchor channel for tension loading, concrete blow out, in. (mm)
- \( c_{cr,V} \): critical edge distance for anchor channel for shear loading, concrete edge breakout, in. (mm)
- \( c_{\text{nom}} \): nominal concrete cover according to code, in. (mm)
- \( d_1 \): width of head of I-anchors or diameter of head of round anchor, as shown in Figure 14 of this annex, in. (mm)
- \( d_2 \): shaft diameter of round anchor, as shown in Figure 15 of this annex, in. (mm)
- \( d_a \): diameter of anchor reinforcement, in. (mm)
- \( d_s \): diameter of channel bolt, in. (mm)
- \( e_1 \): distance between shear load and concrete surface, in. (mm)
- \( e_s \): distance between the axis of the shear load and the axis of the anchor reinforcement resisting the shear load, in. (mm)
- \( f \): distance between anchor head and surface of the concrete, in. (mm)
- \( f_c \): specified concrete compressive strength, psi (MPa)
- \( f_{uta} \): specified ultimate tensile strength of anchor, psi (MPa)
- \( f_{utc} \): specified ultimate tensile strength of channel, psi (MPa)
- \( f_{utb} \): specified ultimate tensile strength of channel bolt, psi (MPa)
- \( f_y \): specified yield tensile strength of steel, psi (MPa)
- \( f_{ya} \): specified yield strength of anchor, psi (MPa)
- \( f_{yc} \): specified yield strength of channel, psi (MPa)
- \( f_{yb} \): specified yield strength of channel bolt, psi (MPa)
- \( h \): thickness of concrete member, as shown in Figure 14, in. (mm)
- \( h_{ch} \): height of channel, as shown in Figure 14, in. (mm)
- \( h_{cr,V} \): critical member thickness, in. (mm)
- \( h_{ef} \): effective embedment depth, as shown in Figure 14, in. (mm)
- \( k \): load distribution factor, as referenced in Eq. (D-0.a)
- \( k_{cp} \): pryout factor
- \( l \): lever arm of the shear force acting on the channel bolt, in. (mm)
- \( l_n \): influence length of an external load \( N_{ua} \) along an anchor channel in direction of channel bolt, in. (mm)
- \( p \): web thickness of I-anchor, as shown in Figure 15, in. (mm)
- \( s \): spacing of anchors in direction of longitudinal axis of channel, in. (mm)
- \( S_{chb} \): center-to-center distance between two channel bolts in direction of longitudinal axis of channel, in. (mm)
- \( S_{cr} \): anchor spacing required to develop full concrete capacity in absence of anchor reinforcement, in. (mm)
- \( S_{cr,N} \): critical anchor spacing for tension loading, concrete breakout, in. (mm)
- \( S_{\text{max}} \): maximum spacing of anchors of anchor channel, in. (mm)
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- $s_{min}$: minimum spacing of anchors of anchor channel, in. (mm)
- $s_{cr,Nb}$: critical anchor spacing for tension loading, concrete blow-out, in. (mm)
- $s_{cr,V}$: critical anchor spacing for shear loading, concrete edge breakout, in. (mm)
- $w_A$: width of I-shaped anchor, as shown in Figure 14, in. (mm)
- $x$: distance between end of channel and nearest anchor, in. (mm)
- $z$: internal lever arm of the concrete member, in. (mm)
- $A_{bg}$: bearing area of anchor head, in.$^2$ (mm$^2$)
- $A_i$: ordinate at the position of the anchor $i$, as illustrated in Figure 2, in. (mm)
- $A_{se,N}$: effective cross-sectional area of anchor or channel bolt in tension, in.$^2$ (mm$^2$)
- $A_{se,V}$: effective cross-sectional area of channel bolt in shear, in.$^2$ (mm$^2$)
- $I_p$: moment of inertia of the channel about principal $y$-axis, in.$^4$ (mm$^4$)
- $M_1$: bending moment on fixture around axis in direction 1, lbf-in. (Nm)
- $M_2$: bending moment on fixture around axis in direction 2, lbf-in. (Nm)
- $M_{s,flex}$: nominal flexural strength of the anchor channel, lbf-in. (Nm)
- $M_{s,flex,allowable,ASD}$: allowable bending moment due to tension loads for use in allowable stress design environments, lbf-in. (Nm)
- $M_{ss}$: flexural strength of the channel bolt, lbf-in. (Nm)
- $M'_{ss}$: nominal flexural strength of the channel bolt, lbf-in. (Nm)
- $M_{u,flex}$: bending moment on the channel due to tension loads, lbf-in. (Nm)
- $N_b$: basic concrete breakout strength of a single anchor in tension, lbf (N)
- $N_{ca}$: nominal strength of anchor reinforcement to take up tension loads, lbf (N)
- $N_{cb}$: concrete breakout strength of a single anchor of anchor channel in tension, lbf (N)
- $N_n$: lowest nominal tension strength of an anchor from all appropriate failure modes under tension, lbf (N)
- $N_p$: pullout strength of a single anchor of an anchor channel in tension, lbf (N)
- $N_{pn}$: nominal pullout strength of a single anchor of an anchor channel in tension, lbf (N)
- $N_{ic}$: nominal tension strength of one anchor from all concrete failure modes (lowest value of $N_{cb}$ (anchor channels without anchor reinforcement to take up tension loads) or $N_{ca}$ (anchor channels with anchor reinforcement to take up tension loads), $N_{pn}$, and $N_{sa}$), lbf (N)
- $N_{ns}$: nominal steel strength of anchor channel loaded in tension (lowest value of $N_{sa}$, $N_{sc}$ and $N_{sl}$), lbf (N)
- $N_{ns,a}$: nominal tension strength for steel failure of anchor or connection between anchor and channel (lowest value of $N_{sa}$ and $N_{sc}$), lbf (N)
- $N_{sa}$: nominal tensile steel strength of a single anchor, lbf (N)
- $N_{sc}$: nominal tensile steel strength of the connection between anchor and channel profile, lbf (N)
- $N_{sl}$: nominal tensile strength of the local bending of the channel lips, lbf (N)
- $N_{ss}$: nominal tensile strength of a channel bolt, lbf (N)
- $N_{ua}$: factored tension load on anchor channel, lbf (N)
- $N_{ua}$: factored tension load on anchor $i$ of the anchor channel, lbf (N)
- $N_{ua,b}$: factored tension load on a single anchor of the anchor channel, lbf (N)
- $N_{ua,i}$: factored tension load on anchor $i$ of the anchor channel, lbf (N)
- $N_{ua,bb}$: factored tension load on a channel bolt, lbf (N)
- $N_{ua,br}$: factored tension load acting on the anchor reinforcement, lbf (N)
- $T_{allowable,ASD}$: allowable tension load for use in allowable stress design environments, lbf (N)
- $T_{int}$: Installation torque moment given in the manufacturer's installation instruction, lbf-ft. (Nm)
- $V_{allowable,ASD}$: allowable shear load for use in allowable stress design environments, lbf (N)
- $V_b$: basic concrete breakout strength in shear of a single anchor, lbf (N)
- $V_{ca,y}$: nominal strength of the anchor reinforcement of one anchor to take up shear loads perpendicular to the channel axis, lbf (N)
- $V_{ca,y,max}$: maximum value of $V_{ca,y}$ of one anchor to be used in design, lbf (N)
- $V_{cb,y}$: nominal concrete breakout strength in shear perpendicular to the channel axis of an anchor channel, lbf (N)
- $V_{cp}$: nominal pryout strength of a single anchor, lbf (N)
- $V_{cp,y}$: nominal pryout strength perpendicular to the channel axis of a single anchor, lbf (N)
V_{n,y}  lowest nominal steel strength from all appropriate failure modes under shear perpendicular to the channel axis, lbf (N)

V_{nc}  nominal shear strength of one anchor from all concrete failure modes (lowest value of V_{ca} (anchor channels with anchor reinforcement to take up shear loads) or V_{cs} (anchor channels with anchor reinforcement to take up shear loads) and V_{co}), lbf (N)

V_{ns}  nominal steel strength of anchor channel loaded in shear (lowest value of V_{sa}, V_{sc}, and V_{sl}), lbf (N)

V_{ns,a}  nominal shear strength for steel failure of anchor or connection between anchor and channel (lowest value of V_{sa} and V_{sc}), lbf (N)

V_{sa,y}  nominal shear steel strength perpendicular to the channel axis of a single anchor, lbf (N)

V_{sc,y}  nominal shear strength of connection between one anchor bolt and the anchor channel, lbf (N)

V_{sl,y}  nominal shear strength perpendicular to the channel axis of the local bending of the channel lips, lbf (N)

V_{ss}  nominal strength of channel bolt in shear, lbf (N)

V_{ss,M}  nominal strength of channel bolt in case of shear with lever arm, lbf (N)

V_{ua}  factored shear load on anchor channel, lbf (N)

V_{ua,y}  factored shear load on anchor channel perpendicular to the channel axis, lbf (N)

V_{ua}^{f}  factored shear load on a single anchor of the anchor channel, lbf (N)

V_{ua,i}^{f}  factored shear load on anchor i of the anchor channel, lbf (N)

V_{ua,y,i}^{f}  factored shear load on anchor i of the anchor channel perpendicular to the channel axis, lbf (N)

V_{ua}^{f}  factored shear load on a channel bolt, lbf (N)

V_{ub,y}^{f}  factored shear load on a channel bolt perpendicular to the channel axis, lbf (N)

V_{y,allowable,ASD}  allowable shear load perpendicular to the channel axis for use in allowable stress design environments, lbf (N)

\( \alpha \)  exponent of interaction shear equation [-]

\( \alpha_{ASD} \) conversion factor for allowable stress design [-]

\( \alpha_{ch,N} \) factor to account for the influence of channel size on concrete breakout strength in tension [-]

\( \alpha_{M} \) factor to account for the influence of restraint of fixture on the flexural strength of the channel bolt [-]

\( \alpha_{ch,V} \) factor to account for the influence of channel size and anchor diameter on concrete edge breakout strength in shear, \( (\text{lbf}^{1/2}/\text{in.}^{1/3})/\text{(N}^{1/2}/\text{mm}^{1/3}) \)

\( \psi_{c,N} \) modification factor to account for influence of cracked or uncracked concrete on concrete breakout strength [-]

\( \psi_{c,Nb} \) modification factor to account for influence of cracked or uncracked concrete on concrete blowout strength [-]

\( \psi_{c,V} \) modification factor to account for influence of cracked or uncracked concrete for concrete edge breakout strength [-]

\( \psi_{co,N} \) modification factor for corner effects on concrete breakout strength for anchors loaded in tension [-]

\( \psi_{co,Nb} \) modification factor for corner effects on concrete blowout strength for anchors loaded in tension [-]

\( \psi_{co,V} \) modification factor for corner effects on concrete edge breakout strength for anchor channels loaded in shear [-]

\( \psi_{cp,N} \) modification factor for anchor channels to control splitting [-]

\( \psi_{ed,N} \) modification factor for edge effect on concrete breakout strength for anchors loaded in tension [-]

\( \psi_{g,Nb} \) modification factor to account for influence of bearing area of neighboring anchors on concrete blowout strength for anchors loaded in tension [-]

\( \psi_{h,V} \) modification factor to account for influence of member thickness on concrete edge breakout strength for anchor channels loaded in shear [-]

\( \psi_{s,N} \) modification factor to account for influence of location and loading of neighboring anchors on concrete blowout strength for anchor channels loaded in tension [-]

\( \psi_{s,N} \) modification factor to account for influence of location and loading of neighboring anchors on concrete edge breakout strength for anchor channels loaded in shear [-]
FIGURE A—INSTALLATION PARAMETERS FOR ANCHOR CHANNELS

FIGURE B— I- AND T-ANCHORS

FIGURE C—CHANNEL BOLTS
### TABLE 1—INSTALLATION PARAMETERS FOR HALFEN HZA ANCHOR CHANNELS

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Symbol</th>
<th>Units</th>
<th>38/23</th>
<th>53/34</th>
</tr>
</thead>
<tbody>
<tr>
<td>Channel height</td>
<td>$h_{ch}$</td>
<td>in.</td>
<td>0.91</td>
<td>1.34</td>
</tr>
<tr>
<td>Channel width</td>
<td>$b_{ch}$</td>
<td>in.</td>
<td>1.51</td>
<td>2.07</td>
</tr>
<tr>
<td>Moment of inertia, carbon steel</td>
<td>$I_F$</td>
<td>in.$^4$</td>
<td>0.0507</td>
<td>0.2225</td>
</tr>
<tr>
<td>Minimum anchor spacing</td>
<td>$s_{min}$</td>
<td>in.</td>
<td>3.94</td>
<td>3.15</td>
</tr>
<tr>
<td>Maximum anchor spacing</td>
<td>$s_{max}$</td>
<td>in.</td>
<td>9.84</td>
<td>9.84</td>
</tr>
<tr>
<td>Installation height, welded I-anchor</td>
<td>$h_{nom}$</td>
<td>in.</td>
<td>5.94</td>
<td>6.38</td>
</tr>
<tr>
<td>Minimum edge distance</td>
<td>$c_{ac,min}$</td>
<td>in.</td>
<td>2.95</td>
<td>3.94</td>
</tr>
<tr>
<td>End spacing</td>
<td>$x$</td>
<td>in.</td>
<td>0.98</td>
<td>1.38</td>
</tr>
<tr>
<td>Minimum web thickness</td>
<td>$p$</td>
<td>in.</td>
<td>0.24</td>
<td>0.24</td>
</tr>
<tr>
<td>Minimum width of I- or T-anchor</td>
<td>$w_A$</td>
<td>in.</td>
<td>0.98</td>
<td>1.54</td>
</tr>
<tr>
<td>Min member thickness, welded I-anchor</td>
<td>$h_{min}$</td>
<td>in.</td>
<td>7.48</td>
<td>7.48</td>
</tr>
<tr>
<td>Min member thickness, welded T-anchor</td>
<td>$h_{min}$</td>
<td>in.</td>
<td>4.00</td>
<td>4.37</td>
</tr>
</tbody>
</table>

### TABLE 2—COMBINATION ANCHOR CHANNEL – CHANNEL BOLTS

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Symbol</th>
<th>Units</th>
<th>38/23</th>
<th>53/34</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bolt type</td>
<td>HZS</td>
<td>38/23</td>
<td>1)</td>
<td>HZS 53/34 1)</td>
</tr>
<tr>
<td>Diameter</td>
<td>$d_s$</td>
<td>(mm)</td>
<td>(12)</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(mm)</td>
<td>(16)</td>
<td>(16)</td>
</tr>
</tbody>
</table>

1) Hammer-head channel bolts

### TABLE 3—HZA ANCHOR CHANNELS: STATIC STEEL STRENGTH IN TENSION

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Symbol</th>
<th>Units</th>
<th>38/23</th>
<th>53/34</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nominal strength for local bending of channel lips, tension</td>
<td>$N_{sc}$</td>
<td>lbf</td>
<td>8,840</td>
<td>17,682</td>
</tr>
<tr>
<td>Nominal strength for local bending of channel lips, tension for seismic design</td>
<td>$N_{sc,seis}$</td>
<td>lbf</td>
<td>8,840</td>
<td>17,682</td>
</tr>
<tr>
<td>Nominal steel strength of a single anchor in tension</td>
<td>$N_{sa}$</td>
<td>lbf</td>
<td>12,140</td>
<td>18,938</td>
</tr>
<tr>
<td>Nominal steel strength of a single anchor in tension for seismic design</td>
<td>$N_{sa,seis}$</td>
<td>lbf</td>
<td>12,140</td>
<td>18,938</td>
</tr>
<tr>
<td>Nominal tension strength connection channel / anchor</td>
<td>$N_{tc}$</td>
<td>lbf</td>
<td>8,840</td>
<td>17,682</td>
</tr>
<tr>
<td>Nominal tension strength connection channel / anchor for seismic design</td>
<td>$N_{tc,seis}$</td>
<td>lbf</td>
<td>8,840</td>
<td>17,682</td>
</tr>
<tr>
<td>Nominal bending strength</td>
<td>$M_{t,b}$</td>
<td>lbf·in.</td>
<td>14,721</td>
<td>36,241</td>
</tr>
<tr>
<td>Nominal bending strength for seismic design</td>
<td>$M_{t,b,seis}$</td>
<td>lbf·in.</td>
<td>14,721</td>
<td>36,241</td>
</tr>
</tbody>
</table>

### TABLE 4—HZA ANCHOR CHANNELS: STATIC CONCRETE STRENGTH IN TENSION

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Symbol</th>
<th>Units</th>
<th>38/23</th>
<th>53/34</th>
</tr>
</thead>
<tbody>
<tr>
<td>Embedment depth, welded I-anchor</td>
<td>$h_{ef}$</td>
<td>in.</td>
<td>5.75</td>
<td>6.18</td>
</tr>
<tr>
<td>Embedment depth, welded T-anchor</td>
<td>$h_{ef}$</td>
<td>in.</td>
<td>3.03</td>
<td>3.58</td>
</tr>
<tr>
<td>Area of anchor head</td>
<td>$A_{avg}$</td>
<td>in.$^4$</td>
<td>0.43</td>
<td>0.66</td>
</tr>
<tr>
<td>Critical edge distance</td>
<td>$c_{ac}$</td>
<td>in. (mm)</td>
<td>$3 \times h_{ef}$</td>
<td></td>
</tr>
<tr>
<td>Strength reduction factor</td>
<td>$\phi$</td>
<td></td>
<td>0.70</td>
<td></td>
</tr>
</tbody>
</table>

For SI: 1 in. = 25.4 mm, 1 lbf = 4.448 N, 1 lbf·in. = 8.85 Nm
### TABLE 5—HZA ANCHOR CHANNELS: STATIC STEEL STRENGTH IN SHEAR AND INTERACTION EXPONENTS

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Symbol</th>
<th>Units</th>
<th>Anchor channel sizes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>38/23</td>
</tr>
<tr>
<td>Nominal strength for local bending of channel lips in shear</td>
<td>$V_{sl,y}$</td>
<td>lbf</td>
<td>8,840</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(kN)</td>
<td>(39.3)</td>
</tr>
<tr>
<td>Strength reduction factor</td>
<td>$\phi$</td>
<td>-</td>
<td>0.75</td>
</tr>
<tr>
<td>Nominal strength for local bending of channel lips in shear for seismic design</td>
<td>$V_{sl,y,seis}$</td>
<td>lbf</td>
<td>8,840</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(kN)</td>
<td>(39.3)</td>
</tr>
<tr>
<td>Strength reduction factor</td>
<td>$\phi$</td>
<td>-</td>
<td>0.65</td>
</tr>
<tr>
<td>Nominal steel strength of a single anchor in shear</td>
<td>$V_{sa,y}$</td>
<td>lbf</td>
<td>8,840</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(kN)</td>
<td>(39.3)</td>
</tr>
<tr>
<td>Strength reduction factor</td>
<td>$\phi$</td>
<td>-</td>
<td>0.75</td>
</tr>
<tr>
<td>Nominal steel strength of a single anchor in shear for seismic design</td>
<td>$V_{sa,y,seis}$</td>
<td>lbf</td>
<td>8,840</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(kN)</td>
<td>(39.3)</td>
</tr>
<tr>
<td>Strength reduction factor</td>
<td>$\phi$</td>
<td>-</td>
<td>0.65</td>
</tr>
</tbody>
</table>

For SI: 1 in. = 25.4 mm, 1 lbf = 4.448 N
For inch-pound units: 1 mm = 0.03937 in., 1 N = 0.2248 lbf

### TABLE 6—HZA ANCHOR CHANNELS: STATIC CONCRETE STRENGTH IN SHEAR

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Symbol</th>
<th>Units</th>
<th>Anchor channel sizes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>38/23</td>
</tr>
<tr>
<td>Pryout failure, factor</td>
<td>$k_{cp}$</td>
<td>-</td>
<td>2.0</td>
</tr>
<tr>
<td>Strength reduction factor</td>
<td>$\phi$</td>
<td>-</td>
<td>0.75</td>
</tr>
</tbody>
</table>

### TABLE 7—HZS CHANNEL BOLTS: STATIC STEEL STRENGTH IN TENSION

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Symbol</th>
<th>Units</th>
<th>Grade / Material</th>
<th>Anchor channel sizes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Grade / Material</td>
<td>38/23</td>
</tr>
<tr>
<td>Nominal tensile strength, $N_{sa}$</td>
<td>lbf</td>
<td>8.8</td>
<td>15,161</td>
<td>28,236</td>
</tr>
<tr>
<td></td>
<td>(kN)</td>
<td></td>
<td>(67.4)</td>
<td>(125.6)</td>
</tr>
<tr>
<td>Nominal tensile strength for seismic design</td>
<td>$N_{sa,seis}$</td>
<td>lbf</td>
<td>8.8</td>
<td>15,161</td>
</tr>
<tr>
<td></td>
<td>(kN)</td>
<td></td>
<td>(67.4)</td>
<td>(125.6)</td>
</tr>
<tr>
<td>Strength reduction factor</td>
<td>$\phi$</td>
<td>-</td>
<td>0.65</td>
<td></td>
</tr>
</tbody>
</table>

### TABLE 8—HZS CHANNEL BOLTS: STATIC STEEL STRENGTH IN SHEAR

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Symbol</th>
<th>Units</th>
<th>Grade / Material</th>
<th>Anchor channel sizes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Grade / Material</td>
<td>38/23</td>
</tr>
<tr>
<td>Nominal shear strength</td>
<td>$V_{ss}$</td>
<td>lbf</td>
<td>8.8</td>
<td>9,097</td>
</tr>
<tr>
<td></td>
<td>(kN)</td>
<td></td>
<td>(40.5)</td>
<td>(75.4)</td>
</tr>
<tr>
<td>Nominal shear strength for seismic design</td>
<td>$V_{ss,seis}$</td>
<td>lbf</td>
<td>8.8</td>
<td>9,097</td>
</tr>
<tr>
<td></td>
<td>(kN)</td>
<td></td>
<td>(40.5)</td>
<td>(75.4)</td>
</tr>
<tr>
<td>Strength reduction factor for steel failure under shear</td>
<td>$\phi$</td>
<td>-</td>
<td>0.60</td>
<td></td>
</tr>
</tbody>
</table>

For SI: 1 in. = 25.4 mm, 1 lbf = 4.448 N, 1 lbf-in. = 8.85 Nm
For inch-pound units: 1 mm = 0.03937 in., 1 N = 0.2248 lbf, 1 lbf-in. = 0.113 lbf-in
### TABLE 9—HZA ANCHOR CHANNELS AND HZS CHANNEL BOLTS: MATERIAL SPECIFICATION AND PROPERTIES

<table>
<thead>
<tr>
<th>Component</th>
<th>Material / Strength class</th>
<th>Coating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Channel profile</td>
<td>Carbon steel</td>
<td>Hot-dip galvanized ≥ 55 μm</td>
</tr>
<tr>
<td>Anchor</td>
<td>Carbon steel</td>
<td>Hot-dip galvanized ≥ 55 μm</td>
</tr>
<tr>
<td>Channel bolts</td>
<td>Carbon steel grade 4.6 and 8.8 according to EN ISO 898-1</td>
<td>Hot-dip galvanized ≥ 50 μm or electroplated ≥ 12 μm</td>
</tr>
<tr>
<td>Plain washer 1) ISO 7089 and ISO 7093-1</td>
<td>Product grade A, 200 HV</td>
<td>Hot-dip galvanized or electroplated</td>
</tr>
<tr>
<td>Hexagonal nuts ISO 4032</td>
<td>Property class 5 and 8 according to EN ISO 898-2</td>
<td>Hot-dip galvanized ≥ 50 μm or electroplated ≥ 12 μm</td>
</tr>
</tbody>
</table>

1) Not supplied by Halfen

### TABLE 10—HZS CHANNEL BOLTS: INSTALLATION TORQUES

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Symbol</th>
<th>Units</th>
<th>Position of fixture</th>
<th>Grade / Material</th>
<th>Anchor channel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Installation torque</td>
<td>$T_{\text{inst}}$</td>
<td>lbf-ft. (Nm)</td>
<td>General Fig. E (4.1)</td>
<td>Steel 8.8</td>
<td>38/23</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>52</td>
</tr>
<tr>
<td></td>
<td></td>
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<td></td>
<td></td>
<td>(70)</td>
</tr>
<tr>
<td></td>
<td></td>
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<td></td>
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<td>69</td>
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<td></td>
<td>(94)</td>
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<tr>
<td></td>
<td></td>
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<td></td>
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<td>-</td>
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<td></td>
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<td>136</td>
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<tr>
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<td>173</td>
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<tr>
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<td>(185)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(235)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Steel to steel contact Fig. E (4.2 or 4.3)</td>
<td>Steel 8.8</td>
<td>38/23</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>52</td>
</tr>
<tr>
<td></td>
<td></td>
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<td></td>
<td></td>
<td>(70)</td>
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<tr>
<td></td>
<td></td>
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<td>136</td>
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<td></td>
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<td></td>
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<td></td>
<td>136</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(185)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(360)</td>
</tr>
</tbody>
</table>

For SI: 1 lbf-ft. = 1.3558 Nm

1) $T_{\text{inst}}$ must not be exceeded
2.1 Steel formwork: Fixing with HALFEN channel bolts through formwork penetration
2.2 Steel formwork: Fixing with rivets
2.3 Steel formwork: Fixing with HALFEN fixing cone
2.4 Timber formwork: Fixing with nails
2.5 Timber formwork: Fixing with staples
2.6 Fixing in the top surface of concrete: Fixing by using auxiliary construction
2.7 Fixing in the top surface of concrete: Fixing from above directly to the reinforcement
2.8 Fixing in the top surface of concrete: Fixing to the reinforcement, using the HALFEN ChanClip
Selection of the HALFEN channel bolts in accordance with the planning document.

Insert the channel bolt into the channel. After a 90° turn clockwise, the channel bolt locks into the channel. (Check of the position of the bolt by notch).

Positioning of the channel bolt: At the channel end a minimum clearance must be maintained, which corresponds with the overhang beyond the last anchor.

Tighten the hexagonal nut to the setting torque ($T_{set}$) acc. table stated below. $T_{set}$ must not be exceeded.

4.1: general
4.2 and 4.3: steel to steel contact.

After fixing the nuts, check the correct position of the bolt: If the notch is not perpendicular to the channel length axis, the channel bolt must be released completely, inserted and tightened again.

FIGURE E—HZS CHANNEL BOLTS: INSTALLATION INSTRUCTIONS