Company: **Example calculations** Reference: N/A
Project: N/A Client ref. N/A
Title: N/A
Made by: DH Checked by: JB Date: 14/05/14

Annexe 3: Access davit

Assumptions

This appendix covers normal working conditions only. It does not include loads that may be applied to the davit by a fall arrest system.

The loads on the access davit are the weight of the davit and the weight of an operative with his suspension system, which is either a boatswain's chair or a rope access seat.

The davit is held in position by two angle cleats.
Each cleat must have two fixings.

The lower cleat carries all the weight of the davit and the applied vertical loads. The upper cleat carries the tension loads due to load eccentricity from the wall. Both cleats carry shear loads when the davit is parallel to the wall.

All tension loads in a cleat is assumed to be carried by the fixing closest to the corner of the steel angle section.

The allowable load on a fixing under combined tension and shear loading is calculated using the method given in the Hilti Fastening Technology Manual

Loads on access davit

Access davit		0.19	kN
Weight of operative		0.88	kN
Weight of suspension equipment		0.15	kN
Total dead load on access davit	W_D	0.19	kN
Total live load on access davit	W_L	1.03	kN
Total dead plus live load on access davit	W_{D+L}	1.22	kN

Company: **Example calculations** Reference: N/A
Project: N/A Client ref. N/A
Title: N/A
Made by: DH Checked by: JB Date: 14/05/14

Annexe 3: Access davit

Access davit fixing resistance

Default access davit fixing type	Hilti HUS-H screw anchor
Override davit fixing type	
Base material for fixing	1

(Enter 1 for concrete, 2 for solid brick, enter details for other materials)

Base material for fixing: Concrete

	Default	Override	Units
Access davit fixing diameter	14		mm
Nominal anchor length	90		mm
Drill bit diameter for drilling anchor hole	14		mm
Diameter of fixing hole in cleat	18		mm
Fixing recommended tension resistance	6.80		kN
Fixing recommended shear resistance	18.80		kN

Note that the recommended tension or shear resistance of the fixing is the allowable unfactored or serviceability load. The allowable load values should be appropriate for the base material. For materials other than concrete or solid brick, or for alternative fixings an override fixing tension and shear resistance must be input.

The following are the fixing details used in the calculation:

Access davit fixing type: Hilti HUS-H screw anchor

Access davit fixing diameter	14.0	mm
Nominal anchor length	90.0	mm
Drill bit diameter for drilling anchor hole	14.0	mm
Diameter of fixing hole in cleat	18.0	mm

Base material for fixing: Concrete

Fixing recommended tension resistance	6.80	kN
Fixing recommended shear resistance	18.80	kN

Company: **Example calculations** Reference: N/A
Project: N/A Client ref. N/A
Title: N/A
Made by: DH Checked by: JB Date: 14/05/14

Annexe 3: Access davit

General arrangement of access davit

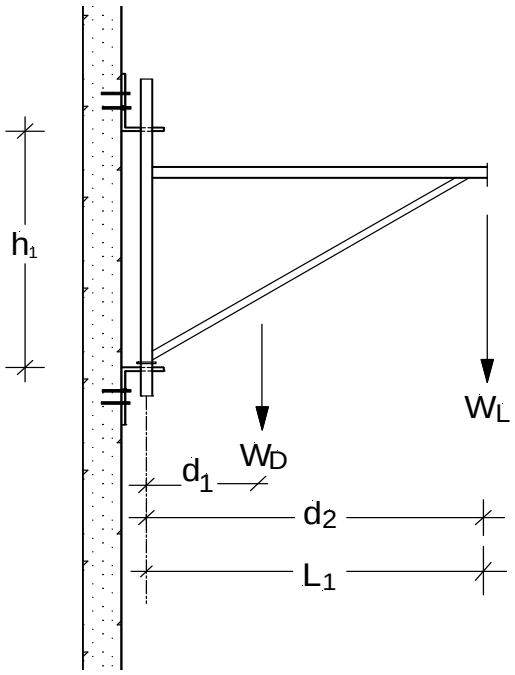

Figure 1: Elevation of access davit

Fixing cleat details Note that each cleat must have two fixings.

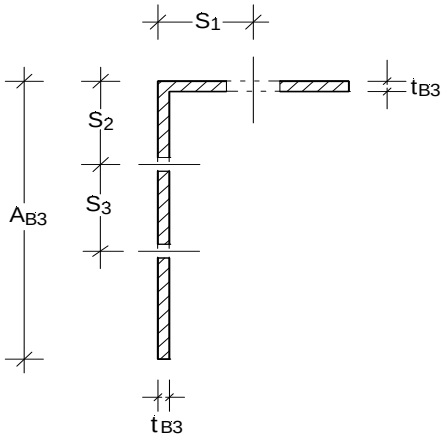

Figure 2a Lower cleat B3

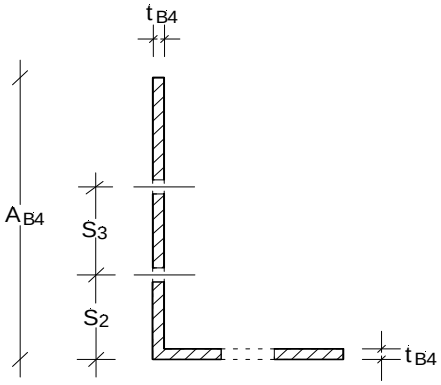

Figure 2b Upper cleat B4

Company: **Example calculations** Reference: N/A
Project: N/A Client ref. N/A
Title: N/A
Made by: DH Checked by: JB Date: 14/05/14

Annexe 3: Access davit

Positions of loads

Refer to Figure 1

The lines of action of the vertical dead and live loads are defined by the distances from the centreline of the vertical tube.

The line of action of the dead load is taken at a distance from the vertical tube equal to one third of the overall width of the access davit.

The line of action of the live load is taken at the davit suspension point.

Overall width of access davit	L_1	1.200	m
Distance to line of action of dead load	d_1	0.400	m
Distance to line of action of live load	d_2	1.200	m
Vertical distance between cleats	h_1	1.200	m

This distance is measured between the horizontal legs of the access davit cleats

Loads at supports for access davit perpendicular to structure

Dead load on lower cleat B3	W_D	0.19	kN
Live load on lower cleat B3	W_L	1.03	kN
Total vertical load on lower cleat B3	W_{D+L}	1.22	kN

Horizontal tension load on upper cleat = $(W_D \times d_1 + W_L \times d_2) / h_1$

Horizontal tension load on upper cleat B4	H_{B4}	1.09	kN

Loads at supports for access davit parallel to structure

Dead load on lower cleat B3	W_D	0.19	kN
Live load on lower cleat B3	W_L	1.03	kN
Total vertical load on lower cleat B3	W_{D+L}	1.22	kN

Horizontal shear load on cleats = $(W_D \times d_1 + W_L \times d_2) / h_1$

Horizontal shear load on cleats B3 and B4	$S_{B3 \text{ and }} S_{B4}$	1.09	kN

Company: **Example calculations** Reference: N/A
Project: N/A Client ref. N/A
Title: N/A
Made by: DH Checked by: JB Date: 14/05/14

Annexe 3: Access davit

Cleat dimensions

Angle section from which cleats are cut	Leg 1 (mm)	Leg 2 (mm)	Thickness (mm)
	200	150	12

For an unequal angle the longer leg is assumed to be vertical

Distance from outside corner of angle to centre of hole in horizontal leg	s_1	55	mm
Distance from outside corner of angle to centre of closest hole in vertical leg	s_2	75	mm
Distance between fixing holes in vertical leg	s_3	75	mm
Diameter of scaffold tube hole in cleat	d_s	50	mm
Diameter of fixing hole in cleat	d_f	18	mm
Width of cleat (length cut from steel angle)	L_B	150	mm

Lower cleat B3 dimensions used in calculations

Length of vertical leg of cleat	A_{B3}	200	mm
Thickness of cleat	t_{B3}	12	mm
Horizontal distance from corner of cleat to centre of access davit vertical tube	s_1	55	mm
Vertical distance from outside corner of cleat to closest fixing	s_2	75	mm
Distance between fixing holes in vertical leg	s_3	75	mm
Diameter of scaffold tube hole in cleat	d_s	50	mm
Diameter of fixing hole in cleat	d_f	18	mm
Width of cleat	L_{B3}	150	mm

Company: **Example calculations** Reference: N/A
Project: N/A Client ref. N/A
Title: N/A
Made by: DH Checked by: JB Date: 14/05/14

Annexe 3: Access davit

Stresses in lower cleat B3 for davit perpendicular to structure Refer to Figure 2a

Vertical load on lower cleat B3	W_{D+L}	1.22	kN
Bending moment at root of angle = W_{D+L} x (s_1-t_{B3})			
Bending moment at root of angle	M_{B3}	0.05	kNm
Effective width of cleat = minimum of L_{B3} and (d_s+ 2 x s_1)			
Effective width of cleat	L_e	150	mm
Bending stress at root of angle = M_{B3} / (1/6 x L_e x (t_{B3})^2)			
Bending stress at root of angle		14.5	N/mm^2
Allowable bending stress in steel cleat		180	N/mm^2
Ratio of bending stress to allowable value		0.08	

The lower cleat is satisfactory for davit perpendicular to the structure

Fixing loads for lower cleat B3 for davit perpendicular to structure

Vertical load on lower cleat B3	W_{D+L}	1.22	kN
Tension load in fixing = W_{D+L} x s_1 / (A_{B3} - s_2)			
Tension load in fixing		0.54	kN
Shear load in fixing		1.22	kN
Combined tension and shear load		1.33	kN
Angle of combined load to tension load		1.16	radians
Angle in degrees		66	degrees
Fixing recommended tension resistance		6.80	kN
Fixing recommended shear resistance		18.80	kN
Fixing recommended combined resistance		11.65	kN
Ratio of tension load to allowable value		0.08	Satisfactory
Ratio of shear load to allowable value		0.06	Satisfactory
Ratio of combined load to allowable value		0.11	Satisfactory

The lower cleat fixing is satisfactory for davit perpendicular to the structure

Company: **Example calculations** Reference: N/A
Project: N/A Client ref. N/A
Title: N/A
Made by: DH Checked by: JB Date: 14/05/14

Annexe 3: Access davit

Stresses in lower cleat B3 for davit parallel to structure Refer to Figure 2a

Vertical load on lower cleat B3	W_{D+L}	1.22	kN

Bending moment at root of angle = W_{D+L} x (s_1-t_{B3})

Bending moment at root of angle	M_{B3}	0.05	kNm

Effective width of cleat = minimum of L_{B3} and (d_s+ 2 x s_1)

Effective width of cleat	L_e	150	mm

Bending stress at root of angle = M_{B3} / (1/6 x L_e x (t_{B3})^2)

Bending stress at root of angle	14.5	N/mm^2
Allowable bending stress in steel cleat	180	N/mm^2

Ratio of bending stress to allowable value 0.08

The lower cleat is satisfactory for davit parallel to the structure

Fixing loads for lower cleat B3 for davit parallel to structure

Vertical load on lower cleat B3	W_{D+L}	1.22	kN
Horizontal load on lower cleat B3	S_{B3}	1.09	kN

Tension load in fixing = W_{D+L} x s_1 / (A_{B3} - s_2) + S_{B3} x s_1 / (L_{B3}/2)
Shear load in fixing = ((W_{D+L})^2 + (S_{B3} x (s_2+s_3)/s_3)^2)^0.5

Tension load in fixing	1.34	kN
Shear load in fixing	2.50	kN
Combined tension and shear load	2.83	kN
Angle of combined load to tension load	1.08	radians
Angle in degrees	62	degrees
Fixing recommended tension resistance	6.80	kN
Fixing recommended shear resistance	18.80	kN
Fixing recommended combined resistance	10.74	kN
Ratio of tension load to allowable value	0.20	Satisfactory
Ratio of shear load to allowable value	0.13	Satisfactory
Ratio of combined load to allowable value	0.26	Satisfactory

The lower cleat fixing is satisfactory for davit parallel to the structure

Company: **Example calculations** Reference: N/A
Project: N/A Client ref. N/A
Title: N/A
Made by: DH Checked by: JB Date: 14/05/14

Annexe 3: Access davit

Upper cleat B4 dimensions

Length of vertical leg of cleat	A_{B4}	200	mm
Thickness of cleat	t_{B4}	12	mm
Horizontal distance from corner of cleat to centre of davit vertical tube	s_1	55	mm
Vertical distance from outside corner of cleat to closest fixing	s_2	75	mm
Distance between fixing holes in vertical leg	s_3	75	mm
Diameter of fixing hole in cleat	d_f	18	mm
Width of cleat	L_{B4}	150	mm

Stresses in upper cleat B4 for davit perpendicular to structure

Horizontal load on upper cleat B4	H_{B4}	1.09	kN

Bending moment at fixing closest to corner of angle = $H_{B4} \times s_2$

Bending moment at fixing position	M_{B4}	0.08	kNm

Effective width of cleat = $L_{B4} - d_f$

Maximum effective width of cleat	L_e	132	mm

Bending stress in cleat at fixing = $M_{B4} / (1/6 \times L_e \times (t_{B4})^2)$

Bending stress in cleat at fixing	26	N/mm^2
Allowable bending stress in steel bracket	180	N/mm^2
Ratio of bending stress to allowable value	0.14	

The upper cleat is satisfactory for davit perpendicular to structure

Fixing loads for upper cleat B4 for davit perpendicular to structure

Horizontal load on upper cleat B4	H_{B4}	1.09	kN

Tension load in fixing = $H_{B4} \times A_{B4} / (A_{B4} - s_2)$

Tension load in fixing	1.75	kN
Fixing recommended tension resistance	6.80	kN
Ratio of tension load to allowable value	0.26	

The upper cleat fixing is satisfactory for davit perpendicular to structure

Company: **Example calculations** Reference: N/A
Project: N/A Client ref. N/A
Title: N/A
Made by: DH Checked by: JB Date: 14/05/14

Annexe 3: Access davit

Stresses in upper cleat B4 for davit parallel to structure

Horizontal load on upper cleat B4	S_{B4}	1.09	kN

The cleat is loaded in line with the plate and stresses are not critical.

Fixing loads for upper cleat B4 for davit parallel to structure

Horizontal load on upper cleat B4	S_{B4}	1.09	kN

Tension load in fixing = S_{B4} x s_1 / (L_{B4}/2)
Shear load in fixing = S_{B4} x (s_2+s_3)/s_3

Tension load in fixing	0.80	kN
Shear load in fixing	2.18	kN
Combined tension and shear load	2.33	kN
Angle of combined load to tension load	1.22	radians
Angle in degrees	70	degrees
Fixing recommended tension resistance	6.80	kN
Fixing recommended shear resistance	18.80	kN
Fixing recommended combined resistance	12.53	kN
Ratio of tension load to allowable value	0.12	Satisfactory
Ratio of shear load to allowable value	0.12	Satisfactory
Ratio of combined load to allowable value	0.19	Satisfactory

The upper cleat fixing is satisfactory for davit parallel to structure

Company: **Example calculations** Reference: N/A
Project: N/A Client ref. N/A
Title: N/A
Made by: DH Checked by: JB Date: 14/05/14

Annexe 3: Access davit

Fixing loads for upper cleat B4 for davit at an intermediate angle to the structure

The fixing to the upper cleat B4 is loaded in tension by both the tension load on the cleat when the davit is perpendicular to the structure and the shear load on the cleat when the davit is parallel to the structure.
In this section, a check is made on the capacity of the fixing for the davit at an intermediate angle between perpendicular and parallel to the structure.

The angle of the davit is measured from its position perpendicular to the structure
Angles are considered at five degree intervals.
Load cases are combined by vector sum.
Note: calculations for the individual of angles are not printed.

Fixing tension load for davit perpendicular to structure	1.75	kN
Fixing shear load for davit perpendicular to structure	0.00	kN
Fixing tension load for davit parallel to structure	0.80	kN
Fixing shear load for davit parallel to structure	2.18	kN
Maximum tension load in fixing for range of angles	1.92	kN
Maximum shear load in fixing for range of angles	2.18	kN
Maximum combined tension and shear load	2.46	kN

Loads at intermediate angles for maximum ratios of applied to allowable loads

Tension load	1.92	kN for davit angle	25	degrees
Shear load	2.18	kN for davit angle	90	degrees
Combined load	2.27	kN for davit angle	35	degrees

Fixing recommended tension resistance	6.80	kN
Fixing recommended shear resistance	18.80	kN
Angle for max combined tension and shear load ratio	35	degrees
Fixing recommended combined resistance	7.58	kN
Ratio of tension load to allowable value	0.28	Satisfactory
Ratio of shear load to allowable value	0.12	Satisfactory
Ratio of combined load to allowable value	0.30	Satisfactory

The upper cleat fixing is satisfactory for intermediate angles of the davit

Company: **Example calculations** Reference: N/A
Project: N/A Client ref. N/A
Title: N/A
Made by: DH Checked by: JB Date: 14/05/14

Annexe 3: Access davit

Summary of access davit fixing design results

Access davit fixing type	Hilti HUS-H screw anchor		
Access davit fixing diameter	14	mm	
Nominal anchor length	90.0	mm	
Drill bit diameter for drilling anchor hole	14.0	mm	
Diameter of fixing hole in cleat	18.0	mm	
Base material for fixing	Concrete		
Fixing recommended tension resistance	6.80	kN	
Fixing recommended shear resistance	18.80	kN	
Angle section from which cleats are cut	Leg 1	200	mm
	Leg 2	150	mm
	Thickness	12	mm
	Length	150	mm

Lower cleat max. stress ratio	0.08	The lower cleat is satisfactory
Lower cleat fixing max. load ratio	0.26	The lower cleat fixing is satisfactory
Upper cleat max. stress ratio	0.14	The upper cleat is satisfactory
Upper cleat fixing max. load ratio	0.30	The upper cleat fixing is satisfactory

The design of the cleats and fixings is satisfactory