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 1: Laddering

Assumptions

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

Vertical loads must be carried by the ladders below the working level and not by the fixings. The eccentricity of all vertical loads is measured from the ladder.

Default calculations are based on the use of 3.0m long ladder sections with ladder fixings spaced at 1.5m centres.
For a 3.0m ladder, the fixings should be 0.75m from each end the ladder.

The calculation method is valid for 4.5m ladder sections provided that fixings are at 1.5m centres with fixings 0.75m from each end. Each 4.5m ladder section will have a minimum of three fixings.
15ft ladders (4.57m) may also be used with fixings at 5ft (1.52m) centres.

There will be some rotational flexibility in the joints between ladder sections. To take account of this, no moment transfer is taken across the joint and bending moments are taken about the joint. This assumption conservatively increases the loads on the top fixing.

Default mass and loads

	Default	Override	Units
Equipment carried by operative	10		kg
Drilling force when installing ladder fixings	10		kg

Unit weights and loads

Equipment carried by operative	10	kg	0.10	kN
Drilling force when laddering	10	kg	0.10	kN

Summary of weights and loads used in this section

Weight of operative	W_o	0.88	kN
Equipment carried by operative	W_e	0.10	kN
Drilling force applied by operative	F_d	0.10	kN

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Ladder fixing resistance

Default ladder fixing type	Hilti GD anchor with GRS screw
Override ladder 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
Ladder anchor diameter	14		mm
Ladder screw diameter	12		mm
Nominal anchor length	90		mm
Fixing recommended tension resistance	2.80		kN

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

The following are the fixing details used in the calculation:

Ladder fixing type	Hilti GD anchor with GRS screw	
Ladder anchor diameter	14.0	mm
Ladder screw diameter	12.0	mm
Nominal anchor length	90.0	mm
Base material for fixing	Concrete	
Fixing recommended tension resistance	2.80	kN

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Dimensions

	Default	Override	Units
Distance of operative weight from ladder	500		mm
Vertical spacing of fixings in one ladder section (Maximum spacing 1.55 metres)	1.500		m
Distance of first fixing above ladder joint (Half spacing of fixings in ladder section)		0.750	m

The following are the dimensions used in the calculation:

Distance of operative weight from ladder	d_1	500	mm
Vertical spacing of fixings in one ladder section	h_1	1.500	m
Distance of first fixing above ladder joint	h_2	0.750	m

Note that the lowest fixing on a ladder section must not be closer to the bottom of the ladder section than half the spacing of the ladder fixings.

Ladder fixing resistance

Ladder fixing type	Hilti GD anchor with GRS screw	
Ladder anchor diameter	14.0	mm
Ladder screw diameter	12.0	mm
Nominal anchor length	90.0	mm
Base material for fixing	Concrete	
Fixing recommended tension resistance	2.80	kN

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Annexe 1: Laddering

Case 1: Operative climbing

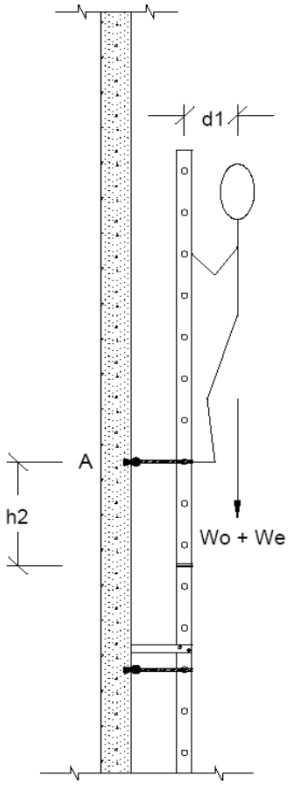

Figure 1a: climbing afer first fixing for a ladder section

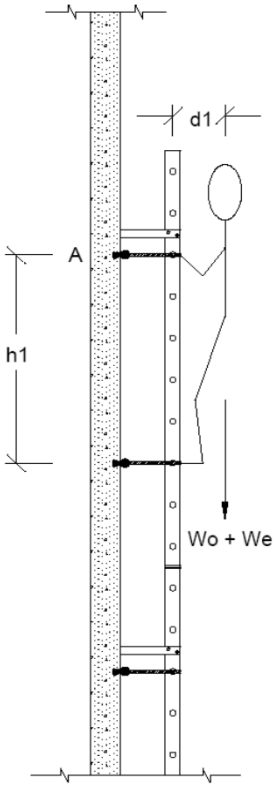

Figure 1b: climbing after second fixing for a ladder section

Refer to Figure 1

In case 1a the tension load in fixing A = (W_o + W_e) x d_1 / h_2
In case 1b the tension load in fixing A = (W_o + W_e) x d_1 / h_1

Case 1a is critical and the tension load in the fixing is 0.65 kN

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Annexe 1: Laddering

Case 2: Operative drilling

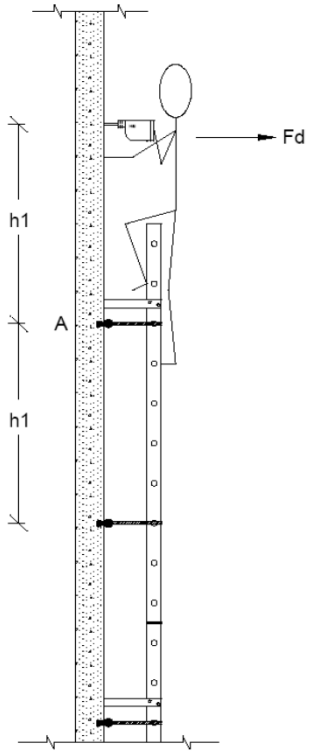

Figure 2a: drilling first fixing for a ladder section

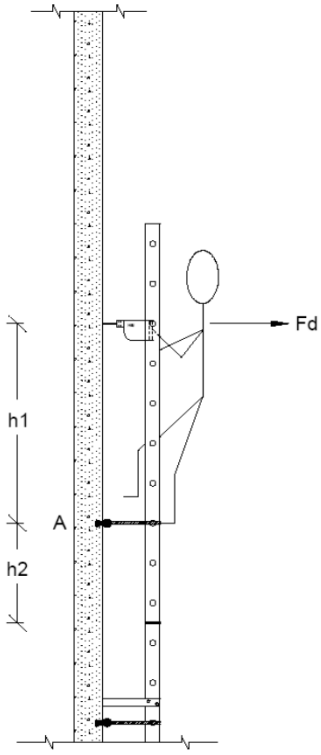

Figure 2b: drilling second fixing for a ladder section

Refer to Figure 2

Consider the load applied to fixing A.
In Case 2a the magnification ratio for the drilling force is (2 x h_1) / h_1 = 2.0
In Case 2b the magnification ratio for the drilling force is (h_1 + h_2) / h_1 = 3.0

Case 2b is critical and the magnification force used in the calculations is 3.0
Case 2b has to be combined with case 1a for climbing for the worst condition.

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Annexe 1: Laddering

Tension loads in ladder fixing

The critical case is when drilling the first fixing for a ladder section
This is a combination of case 1a for climbing and case 2b for drilling.

Tension load in fixing A = tension load for laddering + F_d x 3.0

Maximum tension load in fixing due to climbing	0.65	kN
Maximum tension load in fixing due to drilling force	0.29	kN
Maximum total tension load in fixing during drilling	0.95	kN

Fixing design

Maximum tension load in fixing	0.95	kN

Note: no shear load should be applied to the fixing.
All weights must be carried by the ladders.

Fixing recommended tension resistance	2.80	kN
Proportion of allowable tension load in fixing	0.34	

The fixing is satisfactory