DakoSoftware
Spreadsheets for Structural Engineering

VALIDATION REPORT

SPREADSHEET “EC GE Uplift”

Version 1.0

Date: 1-12-2012
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CONTENTS

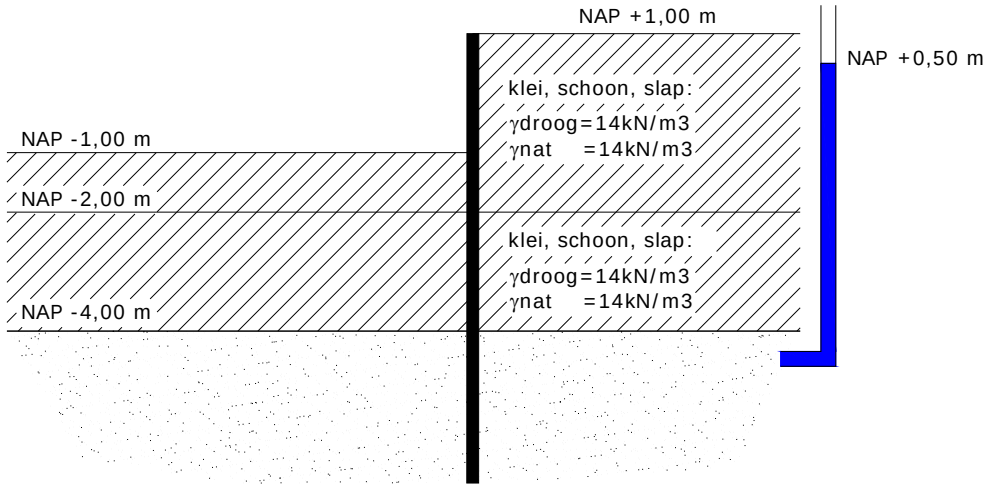
1 VERIFICATION SPREADSHEET

The spread sheet “EC GE Uplift” determines the safety against uplift failure for excavations between retaining walls as well as excavations with slopes according to NEN9997-1

Verification is done by means of carrying out a hand calculation which is presented in paragraph 1.1.

1.1 Verification calculation

1) Calculation for uplift failure between retaining walls

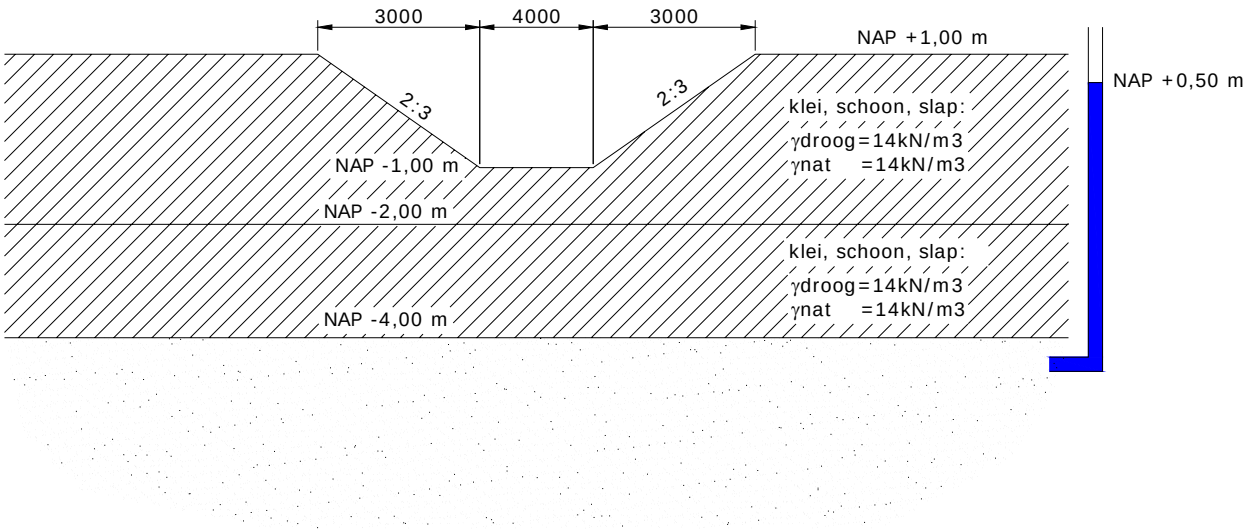


$$p_{z;d} \leq \sum_{j=1}^{j=n} \gamma_{j;d} \times d_{j;d}$$

4.50 m x 10.00 kN/m^3 ≤ (14.00 kN/m^3 x 3.00 m)*0.9
45.00 kN/m^2 > 37.8 kN/m^2 (Not OK)

S.F. = 37.8 / 45 = 0.84
u.c. = 1 / 0.84 = 1.19

2) Calculation for uplift failure with slopes



$p_{z;d} \leq \gamma_{2;d} \times d_{2;d} + f \times \gamma_{1;d} \times d_{1;d}$

$f = 2/\pi \times [(1+b/a) \times \arctan(d_2/(a+b)) - (b/a) \times \arctan(d_2/b)]$
$f = 2/\pi \times [(1+2/3) \times \arctan(3/(3+2)) - (2/3) \times \arctan(3/2)] = 0.1563$

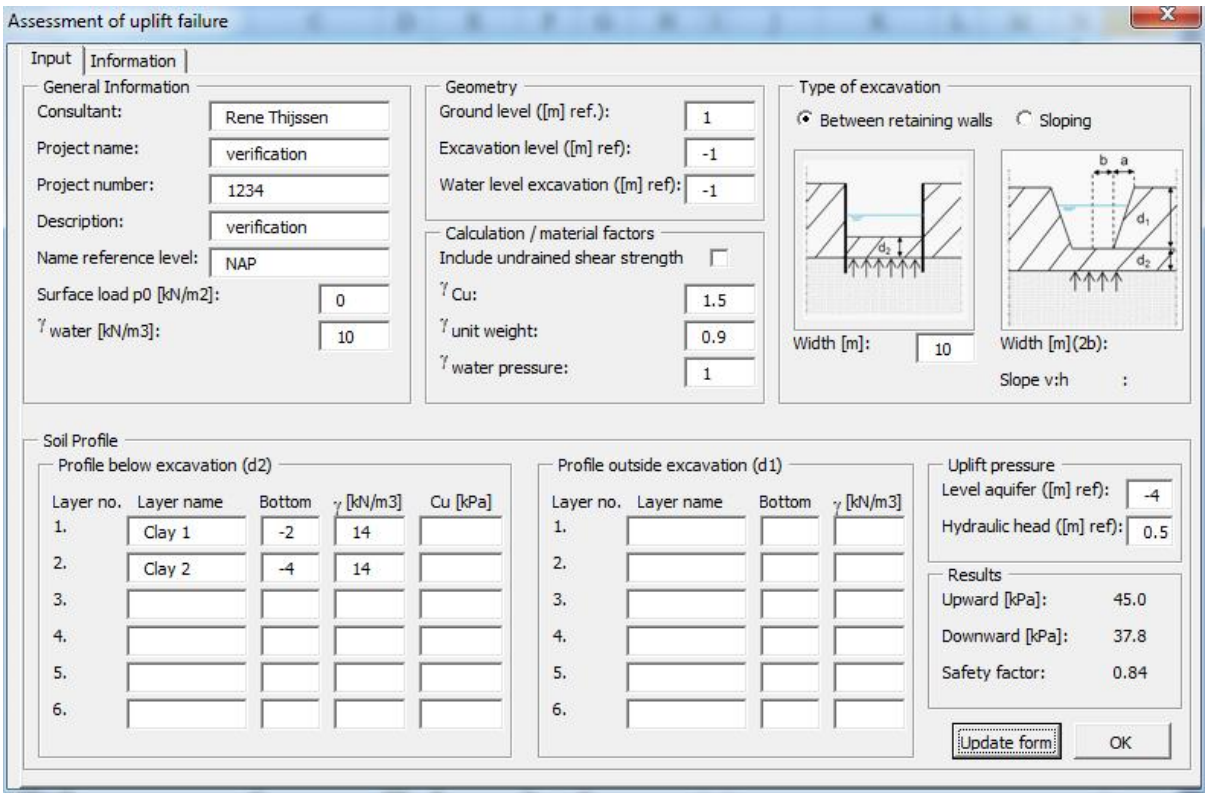
$45.00\ kN/m^2 \leq (14 \times 3.00 + 0.1563 \times 14 \times 2)*0.9$
$45.00\ kN/m^2 > 41.74\ kN/m^2$ (Not OK)

S.F. = 41.74 / 45 = 0.93
u.c. = 1 / 0.93 = 1.08

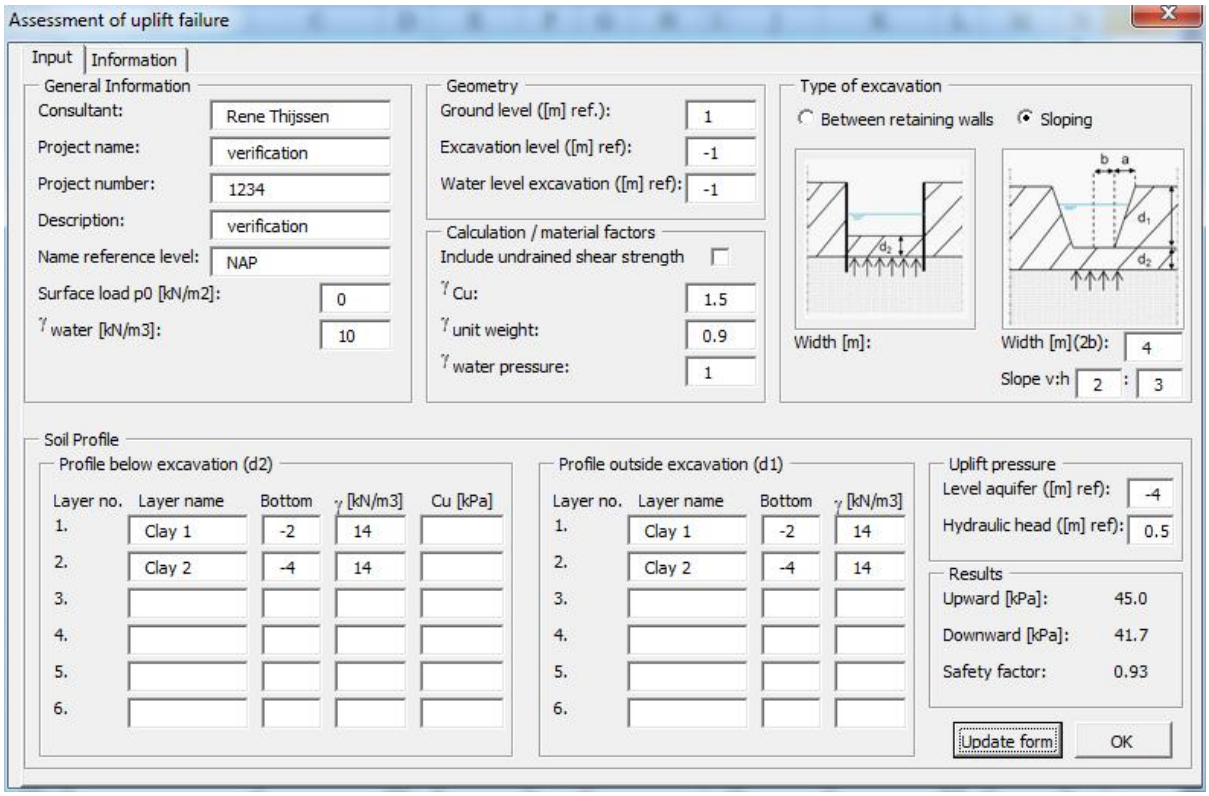
1.2 Spread sheet calculation

The calculation using the spread sheet is presented in Appendix A. Below, concise screen captures of the in- and output are given.

1) Calculation for uplift failure between retaining walls



2) Calculation for uplift failure with slopes



1.3 Summary results

All differences are marginal and acceptable.

APPENDIX A RESULTS SHEET EC GE UPLIFT

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Project name:	**verification**				
Project number:	**1234**	**Part:**	**verification**		
Engineer:	Rene Thijssen	Date:	03-03-13	Version:	1.00

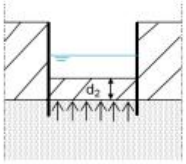
Assessment of uplift failure

General

Ground level	1 [m NAP]
Excavation level	-1 [m NAP]
Water level excavation	-1 [m NAP]
Surface load p_0	0 [kN/m2]
γ_{water}	10 [kN/m3]

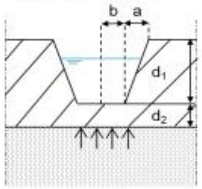
Excavation	Retaining walls [-]
Width excavation B	10 [m]
Include C_u	No [-]
$\gamma_{unit\ weight}$	0.9 [-]
γ_{Cu}	1.5 [-]

Excavation between retaining walls



Width 10

Excavation with slopes

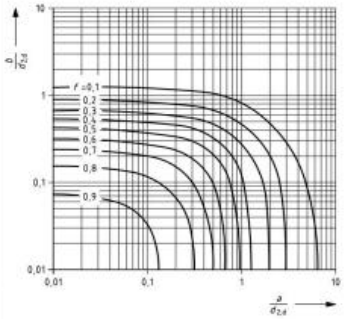


Soil profile below excavation (d2)

Layer name [-]	Bottom layer [m NAP]	h_{layer} [m]	γ_{soil} [kN/m3]	γ*h [kPa]	C_u [kPa]	C_u*h/B [kPa]
Water load (in excavation):				0		
Clay 1	-2	1.0	14	14	0	
Clay 2	-4	2.0	14	28	0	
0	0	0.0	0	0	0	
0	0	0.0	0	0	0	
0	0	0.0	0	0	0	
0	0	0.0	0	0	0	
G2;v;rep [kPa]				42		0
γ [–]				0.9		1.5
G2;v;d [kPa]				37.8		0.0

Soil profile outside excavation (d1)

Layer name [-]	Bottom layer [m NAP]	h_{layer} [m]	γ_{soil} [kN/m3]	γ*h [kPa]
Surface load:				
G1;v;rep [kPa]				0
γ [–]				0.9
G1;v;d [kPa]				
f [-]				
G1;d [kPa]				



Total upward

Level top aquifer	-4	[m NAP]
Hydraulic head aquifer	0.5	[m NAP]
Uplift pressure rep. $u_{dst;rep}$	45	[kPa]
γ_{uplift}	1.0	[-]
Uplift pressure design $u_{dst;d}$	45.0	[kPa]

Total downward

G2;d (weight)	37.8	[kPa]
G2;d (Cu; shear strength)	0.0	[kPa]
G1;d		[kPa]
	37.8	[kPa]

Safety against uplift	**0.84**
Unity check	**1.19**

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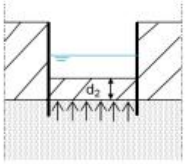
Engineer:	Rene Thijssen	Date:	03-03-13	Version:	1.00

Assessment of uplift failure

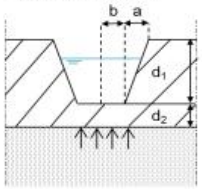
General

Ground level	1 [m NAP]
Excavation level	-1 [m NAP]
Water level excavation	-1 [m NAP]
Surface load p_0	0 [kN/m2]
γ_{water}	10 [kN/m3]

Excavation between retaining walls



Excavation with slopes



Excavation	Slopes [-]
Width excavation B	10 [m]
Include C_u	No [-]
$\gamma_{unit\ weight}$	0.9 [-]
γ_{Cu}	1.5 [-]

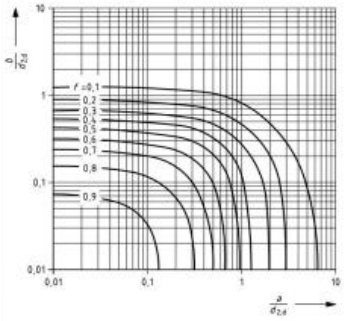
Width [m]:	4
Slope [v:h]:	2:3
a: [m]	3
b: [m]	2

Soil profile below excavation (d2)

Layer name [-]	Bottom layer [m NAP]	h_{layer} [m]	γ_{soil} [kN/m3]	γ*h [kPa]	C_u [kPa]	C_u*h/B [kPa]
Water load (in excavation):				0		
Clay 1	-2	1.0	14	14	0	
Clay 2	-4	2.0	14	28	0	
0	0	0.0	0	0	0	
0	0	0.0	0	0	0	
0	0	0.0	0	0	0	
0	0	0.0	0	0	0	
G2;v;rep [kPa]				42		0
γ [–]				0.9		1.5
G2;v;d [kPa]				37.8		0.0

Soil profile outside excavation (d1)

Layer name [-]	Bottom layer [m NAP]	h_{layer} [m]	γ_{soil} [kN/m3]	γ*h [kPa]
Surface load:				0
Clay 1	-2	2.0	14	28
Clay 2	-4	0.0	14	0
0	0	0.0	0	0
0	0	0.0	0	0
0	0	0.0	0	0
0	0	0.0	0	0
G1;v;rep [kPa]				28
γ [–]				0.9
G1;v;d [kPa]				25.2
f [-]				0.156
G1;d [kPa]				3.9



Total upward

Level top aquifer	-4 [m NAP]
Hydraulic head aquifer	0.5 [m NAP]
Uplift pressure rep. $u_{dst;rep}$	45 [kPa]
γ_{uplift}	1.0 [-]
Uplift pressure design $u_{dst;d}$	45.0 [kPa]

Total downward

G2;d (weight)	37.8 [kPa]
G2;d (Cu; shear strength)	0.0 [kPa]
G1;d	3.9 [kPa]
	41.7 [kPa]

Safety against uplift	**0.93**
Unity check	**1.08**