DakoSoftware
Spreadsheets for Structural Engineering

VALIDATION REPORT

SPREADSHEET “GE Subgrade spread footing”

Version 1.0

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CONTENTS

1 VERIFICATION SPREADSHEET

This spread sheet can be used to make a rough estimate of settlement below an uniformly loaded plate. Verification has been done by carrying out FEM Calculations using the computer programme Plaxis.

1.1 Verification calculations

Assumptions:

- Plane strain: spread footing width 4 m, length 40 m
- Axisymmetric: circular footing diameter 4 m

Soil strata:

Layer	Name	Bottom	Thickness	γ'	Eoed	E50	E50;u
[-]	[-]	[m NAP]	[m]	[kN/m3]	[Mpa]	[Mpa]	[Mpa]
1	E = 15	15	5.00	20	22.2	15.0	16.9
2	E = 5	5	10.00	15	7.4	5.0	5.6
3	E = 25	0	5.00	25	37.0	25.0	28.2

The spread footing is uniformly loaded by 100 kN/m^2.

The following verification calculations have been carried out:

Plaxis 2D:
Plane strain of the strip footing B = 4 m
Axisymmetric for the circular footing D = 4 m

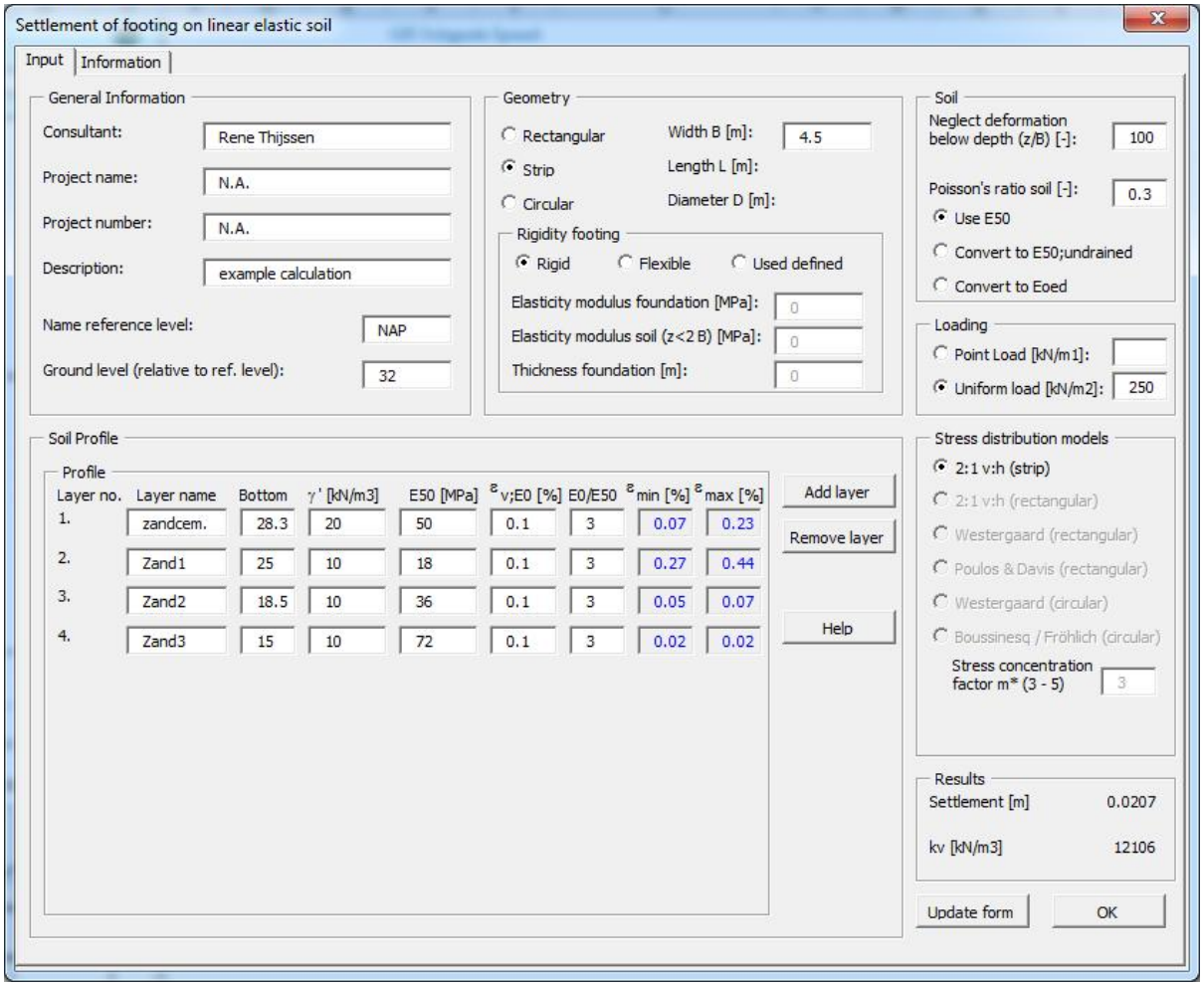
Plaxis 3D:
Rectangular footing B = 4 m, L = 40 m
Circular footing D = 4 m

1.2 Spread sheet calculations

The following models have been used:

Rectangular footing	Circular footing
Plaxis 2D plane strain	Plaxis 2D Axisymmetric
Plaxis 3D	Plaxis 3D
Rectangular 2:1	Westergaard
Strip 2:1, B = 4 m	Boussinesq, m = 3
Westergaard	Boussinesq, m = 5
Poulos & Davis	

Example graphic user interface spread sheet:



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Settlement of footing on linear elastic soil

Input | Information

Information on model

This sheet calculates the elastic settlement below a spread footing. Basis of the model is the presence of Linear Elastic Soil.

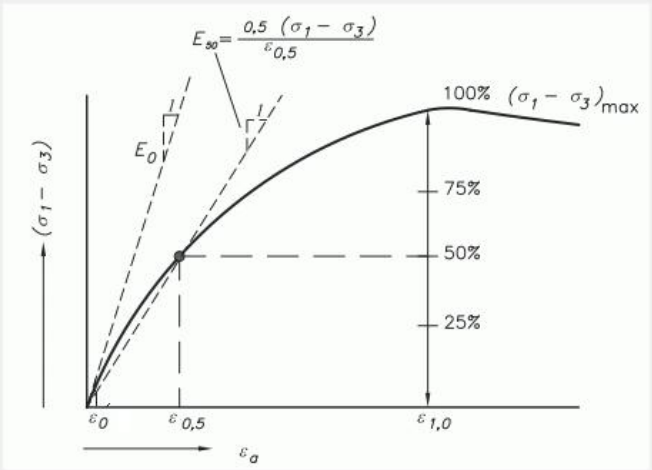
Different stress distribution models are available. Depending on the shape of the spread footing in x- and y-direction, one can choose from these available models.

In the design of spread footings, generally a sufficiently high safety factor on bearing capacity is present (e.g. 2 - 2.5). The use of an E50 Youngs modulus therefore applies when loading up to 50% of the soil strength. For loads (much) smaller than 50% of the capacity, a (much) higher soil stiffness is applicable. To take into account this higher stiffness, the use of the E0 stiffness and associated maximum strain (epsilon0) is incorporated.

The flexibility of the foundation is taken into account by using a flexibility factor. (Rigid: If = 1.0; flexible: If = 0.78) By default, only settlement below the center of the footing is calculated.

It should be noted that this sheet only gives an estimate of the elastic settlement. Effects such as consolidation and creep of impermeable soft sediments are not implemented.

Information on Elasticity Modulus



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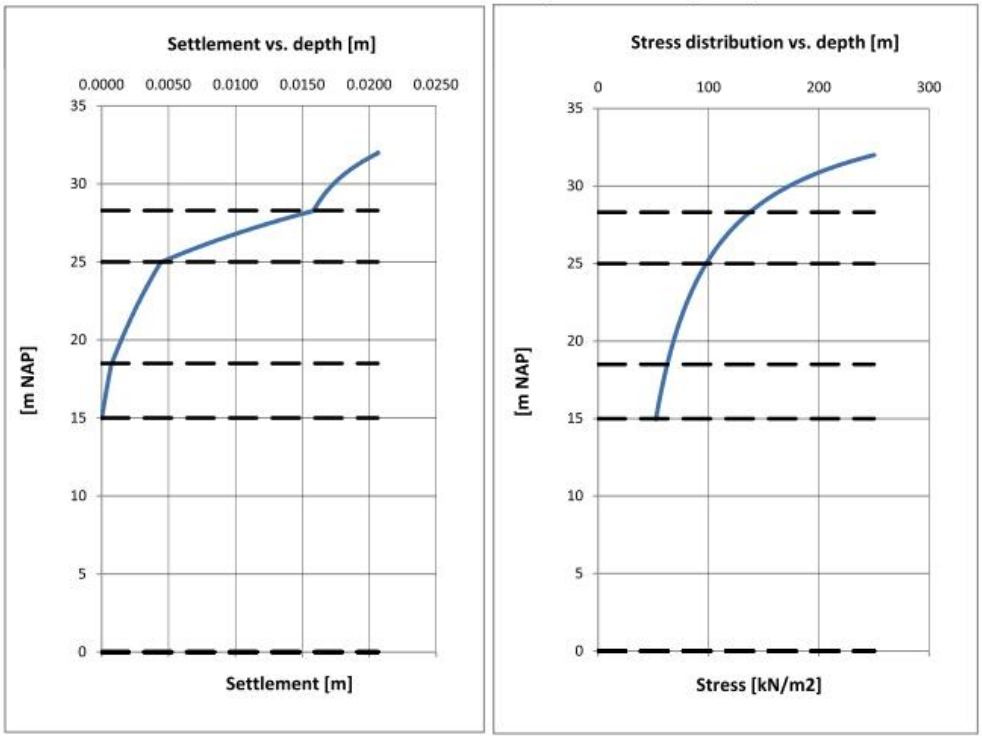
Project name:	**N.A.**				
Project number:	**N.A.**	**Part:**	**example calculation**		
Engineer:	Rene Thijssen		Date: 28-11-2012	Version:	

Calculation of elastic settlement below spread footing

Footing			**Soil**		
Type of footing:	Strip		Neglect deformation below (z/B):	100	-
Width:	4.5	m	Poisson's ratio soil:	0.3	-
			Elasticity modulus:	E50	-
Flexibility:	Rigid		**Loading**		
Flexibility factor:	1	-	Uniform load:	250	kN/m2/m1
Groundlevel:	32	m NAP	Stress distribution model:	2:1 [v:h] distribution (	

Layer	Name	Bottom	h	γ'	E_{oed}	E_{50}	$E_{50;u}$	E_0/E_{50}	$\varepsilon_{s,strain}$	$\sigma_{s,strain}$	ε_{min}	ε_{max}	settlement	contrib.
[-]	[-]	[m NAP]	[m]	[kN/m3]	[Mpa]	[Mpa]	[Mpa]	[-]	[%]	[kN/m2]	[%]	[%]	[m]	[%]
1	zandcem.	28.3	3.70	20	67.3	50.0	57.7	3	0.1	150	0.07	0.23	0.0048	23%
2	Zand1	25	3.30	10	24.2	18.0	20.8	3	0.1	54	0.27	0.44	0.0114	55%
3	Zand2	18.5	6.50	10	48.5	36.0	41.5	3	0.1	108	0.05	0.07	0.0037	18%
4	Zand3	15	3.50	10	96.9	72.0	83.1	3	0.1	216	0.02	0.02	0.0007	4%

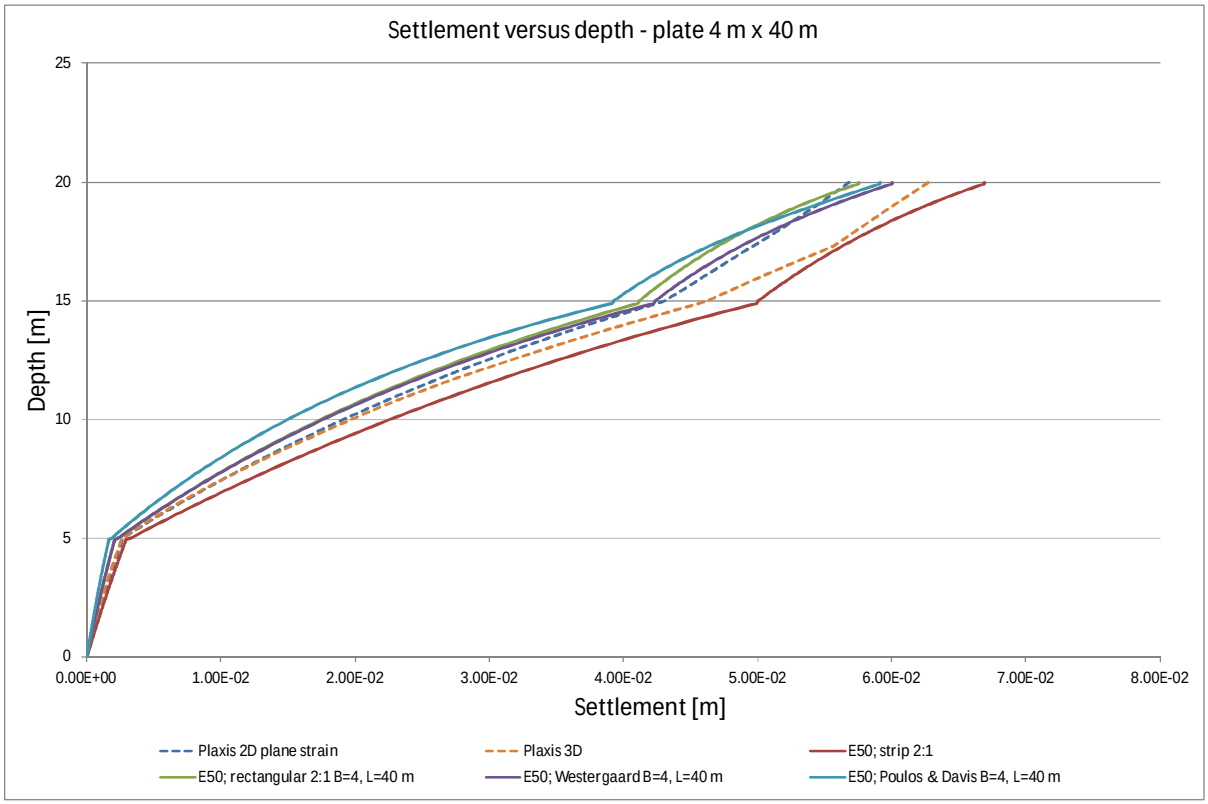
Total settlement: [m]	0.0207
Modulus of subgrade reaction kv: [kN/m3]	12106



1.3 Summary results

Analyses of rectangular footing

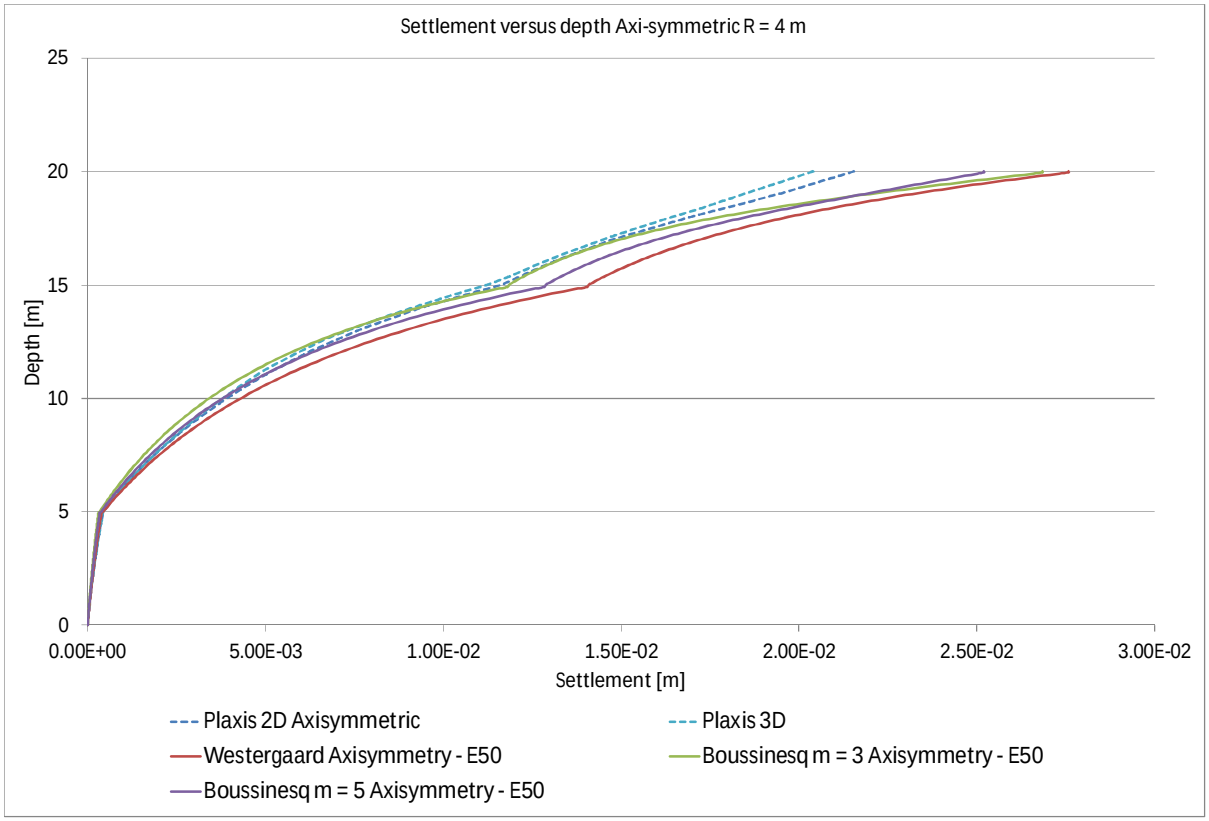
The following diagram shows all calculation results combined.



Model	Settlement footing
Rectangular 2:1	0.057 m
Strip 2:1, B = 4 m	0.067 m
Westergaard	0.060 m
Poulos & Davis	0.059 m
Plaxis 2D plane strain	*0.057 m*
Plaxis 3D	*0.063 m*

It can be seen that all models closely match at this scale.

Analyses of circular footing



Model	Settlement footing
Westergaard	0.028 m
Boussinesq, m = 3	0.027 m
Boussinesq, m = 5	0.025 m
Plaxis 2D Axisymmetric	*0.022 m*
Plaxis 3D	*0.020 m*

It can be seen that Plaxis 2D and 3D give somewhat lower values for settlement than the other models. A rough estimate of settlements of a circular footing can however be properly assessed using the spreadsheet.