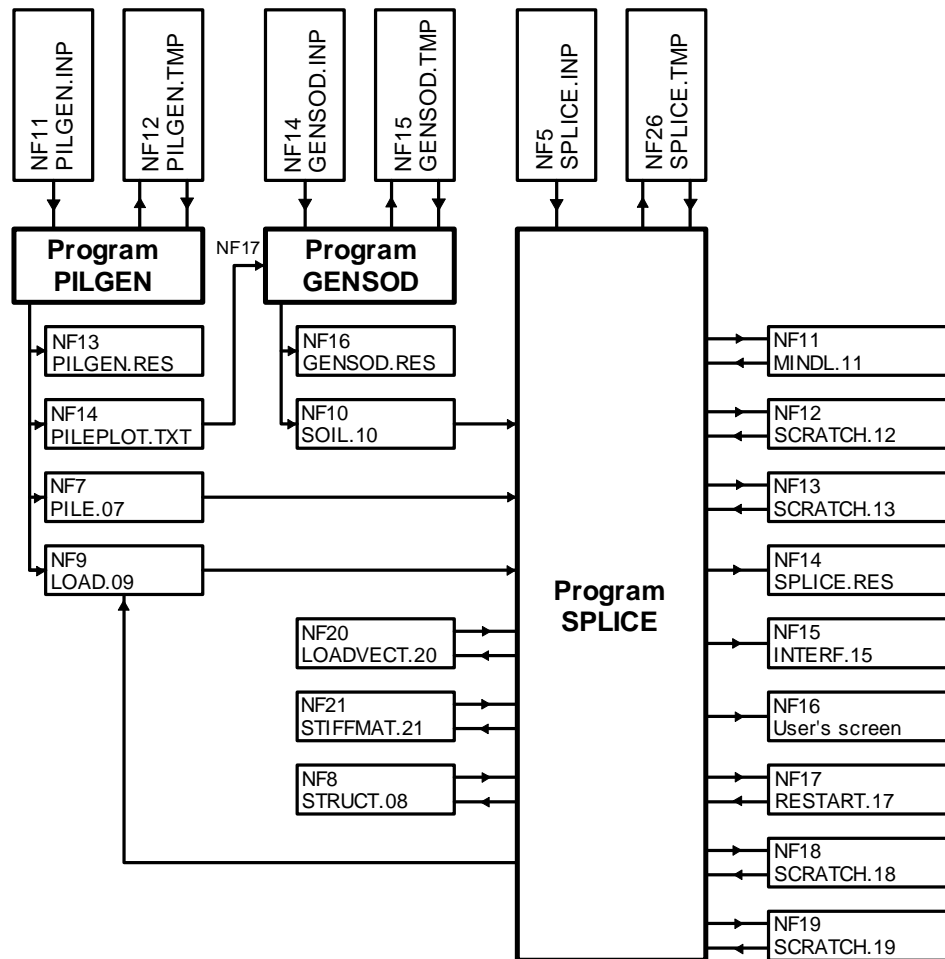


# Novapoint GeoSuite brukermøte

Oslo, 21. oktober 2009

GeoSuite Peler, SPLICE rev.5  
Endringer / funksjonalitet

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Analysis of structure/pile/soil interaction  
 Data flow through programs PILGEN, GENSOD and SPLICE  
 File unit numbers and file names

## GeoSuite 2, SPLICE Improvements

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## **S-1 Multiple Soil Profiles**

- \* Each soil profile read by GENSOD has a specific name.
- \* Several soil profiles may follow each other on the soil data file generated by GENSOD.
- \* Input to SPLICE includes a soil profile name for each pile.
- \* During processing, SPLICE checks the soil profile name for the pile against the soil profile presently in memory. If they differ, SPLICE reads through the soil data file until the wanted profile is found.

## S-2 Pile Axial Capacity Calculation

- \* GENSOD input includes a calculation code for each main layer:
  - 0 = User given skin friction and tip resistance
  - 1 = To be calculated by the API-93 method
  - 2 = To be calculated by the ICP-05 method
  - 3 = To be calculated by the NGI-05 method
  
- \* Soil parameters needed for calculations are:
  - Sand :  $\gamma$  and  $\phi'$  (or Dr or CPT  $q_c$ )
  - Clay :  $\gamma$  , Su and Ip
  
- \* Pile tip capacity is calculated assuming a **plugged** pile tip.  
If not the case, use scaling factors on the q-z curves.

## S-3 Sub-division of Main Soil Layers

- \* User specifies a number of main soil layers in terms of:
  - Layer Z-top and Z-bottom
  
- \* Required soil parameters for each main layer are:
  - Sand :  $\gamma$  and  $\phi'$  or  $D_r$ , or CPT  $q_c$  at layer top and bottom
  - Clay :  $\gamma$  ,  $S_u\text{Top}$ ,  $S_u\text{Bot}$ ,  $I_p$ ,  $E_{ps-50}$  and  $API-J$
  
- \* Each main layer may be divided into a user given number of sub-layers of constant thickness. P-y is calculated at the mid-point of each sub-layer.
  - or
  
- \* Sub-layer Z-bottom values are taken 1 mm below Z pile nodes, obtained from a file generated by PILGEN. P-y is calculated at the bottom of each sub-layer

## S-4 Soil Spring Factors for each Pile

- \* SPLICE reads factors on the stress values of the p-y/t-z/q-z curves for each individual pile.
- \* Can be used to soften, or remove, any pile from the system.

# P-1 Piles with Composite Cross Sections

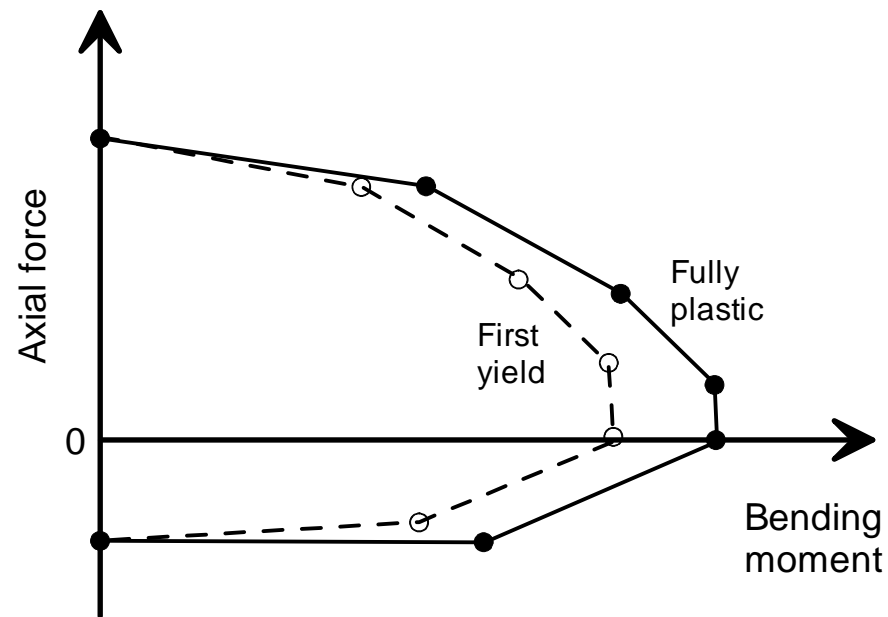
- \* Examples of piles with composite cross sections:
  - Oil and gas wells
  - Concrete piles with a steel core
  - Concrete filled tubular steel piles
  
- \* PILGEN input data includes:
  - Number of main (single) cross sections
  - For each cross section, a code that flags single or composite
  - For the composite cross sections, the IDs for the single cross sections needed to build the wanted cross section
  
- \* PILGEN transfers this info to SPLICE, where the calculation of the EA, EI and  $GIp$  values is carried out



## P-2 Non-linear Pile Cross Sections

Not yet decided to include this in SPLICE rev. 5.

Parameters needed are already part of the PILGEN rev.5 input:



GeoSuite Peler, SPLICE rev.5

## P-3 Pile Stresses Reported by SPLICE

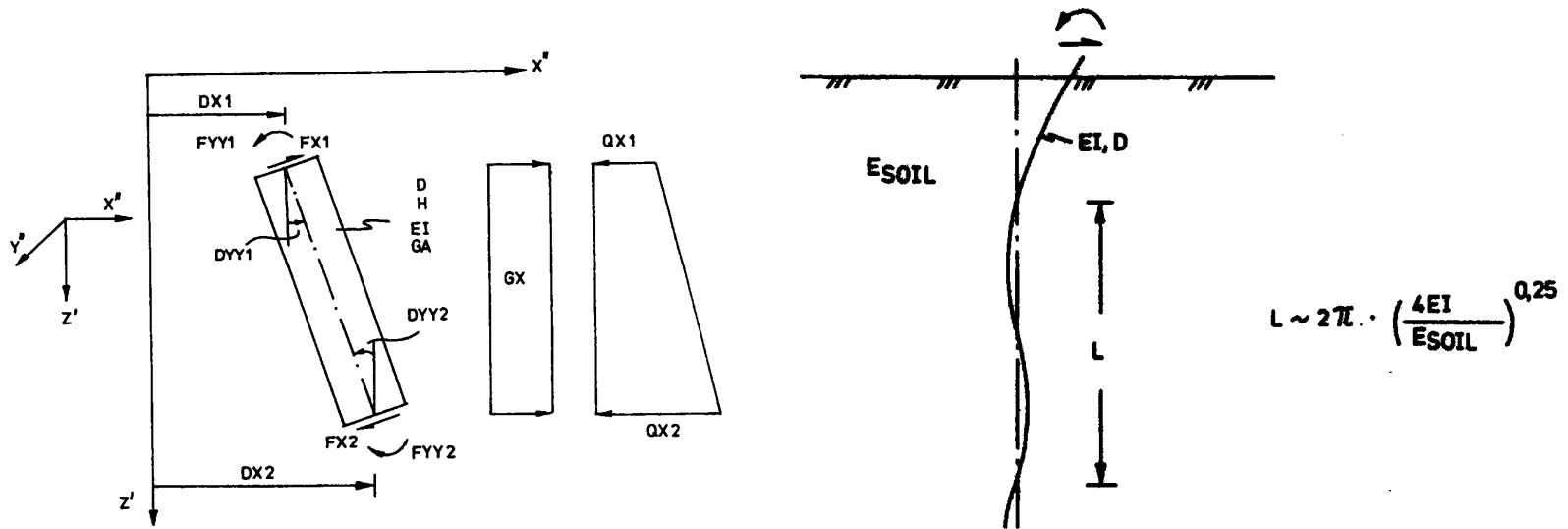
Rev. 4 :  $\sigma_{\text{steel}} = F_{\text{axial}} / A + M_{\text{res}} / W$

Rev. 5 : As above + steel strength utilisation ratios (UR)  
calculated by the NORSOK N-004 or draft  
ISO 19902 codes

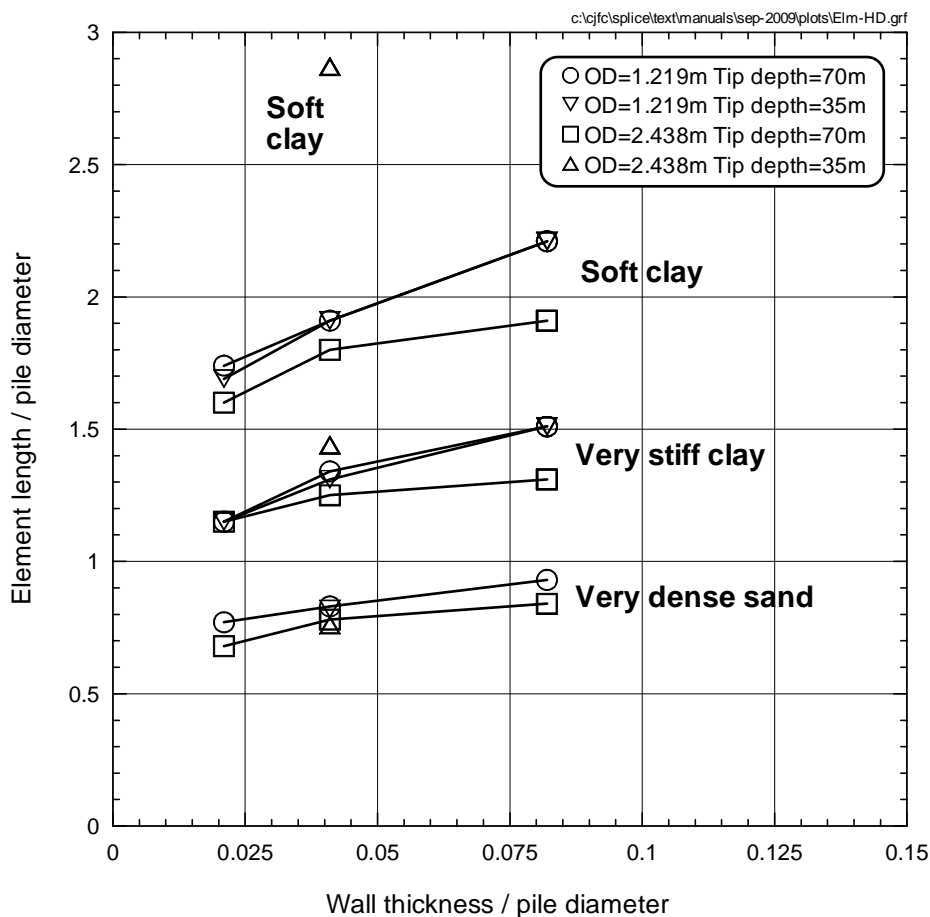
Input : - Pile OD and WT  
- Steel E and  $\sigma_{\text{yield}}$   
-  $F_{\text{axial}}$  and  $M_{\text{res}}$

Result :  $UR = F_{\text{axial}} / F_{\text{cap}} + M_{\text{res}} / M_{\text{cap}} < 1.0$

# P-4 Pile Diameter/Length Ratio Check



# P-4 cont. Pile Diameter/Length Ratio Check

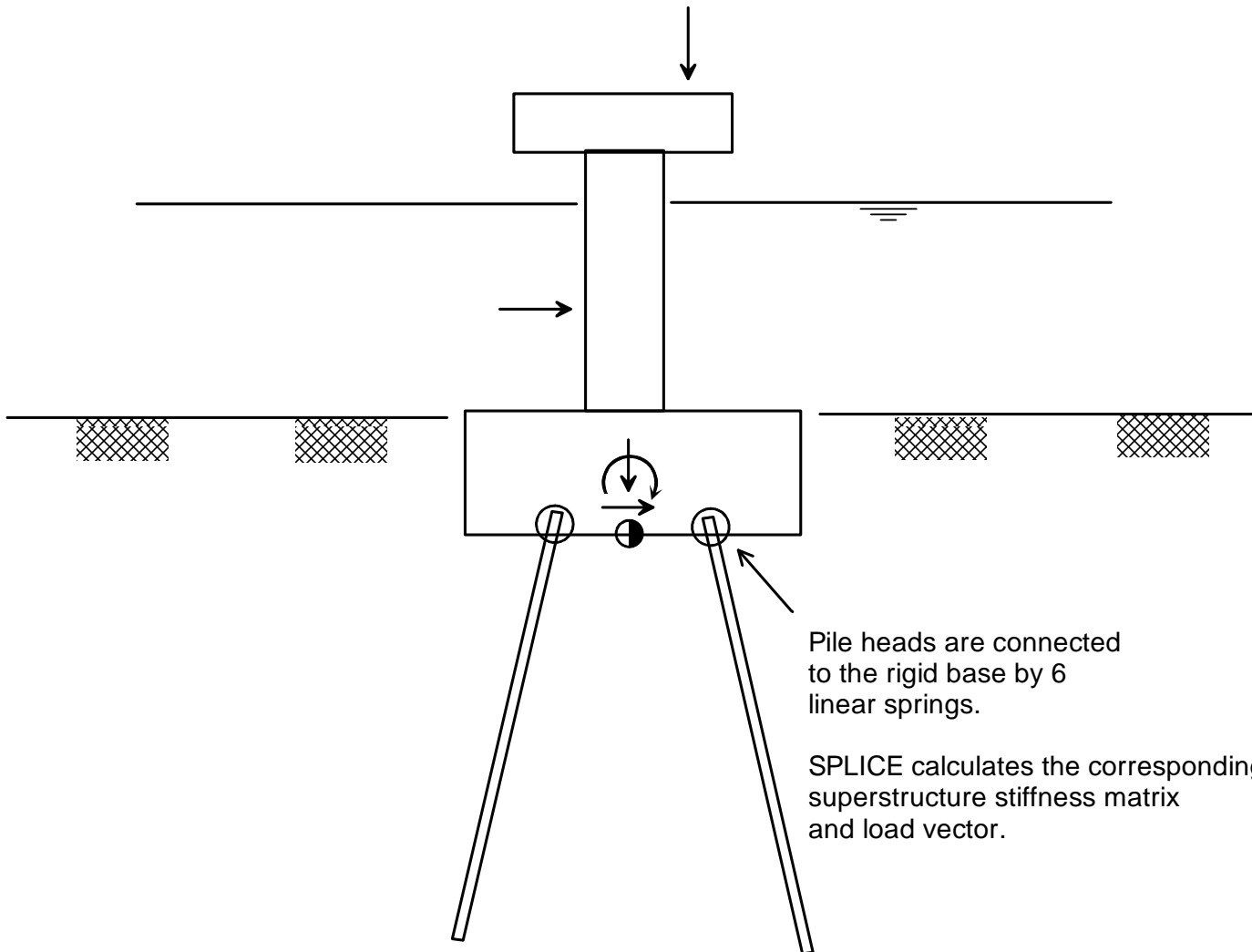


This figure is included in the PILGEN documentation report.

All results shown have 1% error on the pile head shear force.

Conclusion:  
 Clay :  $L/D < 1.0$   
 Sand:  $L/D < 0.7$

## A-2 Rigid Block Stiffness Matrix



## A-2 cont. Rigid Block Stiffness Matrix

Example 3 in SPLICE documentation, offshore platform on 12 piles

Jacket model	Max. pile stress	Max. lateral displ.
-----	-----	-----
Actual matrix	223 MPa, P5	58.3 mm, P5
Rigid jacket	187 MPa, P6	55.2 mm, P8
Rigid block with rotational springs	Kr, kNm/radian	
Kr = 1.0E12	187 MPa, P6	55.2 mm, P8
Kr = 1.0E9	186 MPa, P6	55.4 mm, P8
Kr = 1.0E8	185 MPa, P6	56.3 mm, P8
Kr = 1.0E7	171 MPa, P6	64.6 mm, P8
Kr = 1.0E6	151 MPa, P1	107 mm, P8
Kr = 1.0E5	195 MPa, P5	161 mm, P8
Kr = 0.0	208 MPa, P5	176 mm, P7

# D-1 Error Message Explanations

SPLICE rev. 5 includes more detailed error messages.

Example new message from subroutine AXSLV:

```
**** SR/AXSLV      : An error condition was detected, ID=1110
```

```
NP,NE,DIV1 =    1    12    -2.5000E-01
```

```
Explanation      : Pile NP, element NE, zero division  
                  attempted during axial solution
```

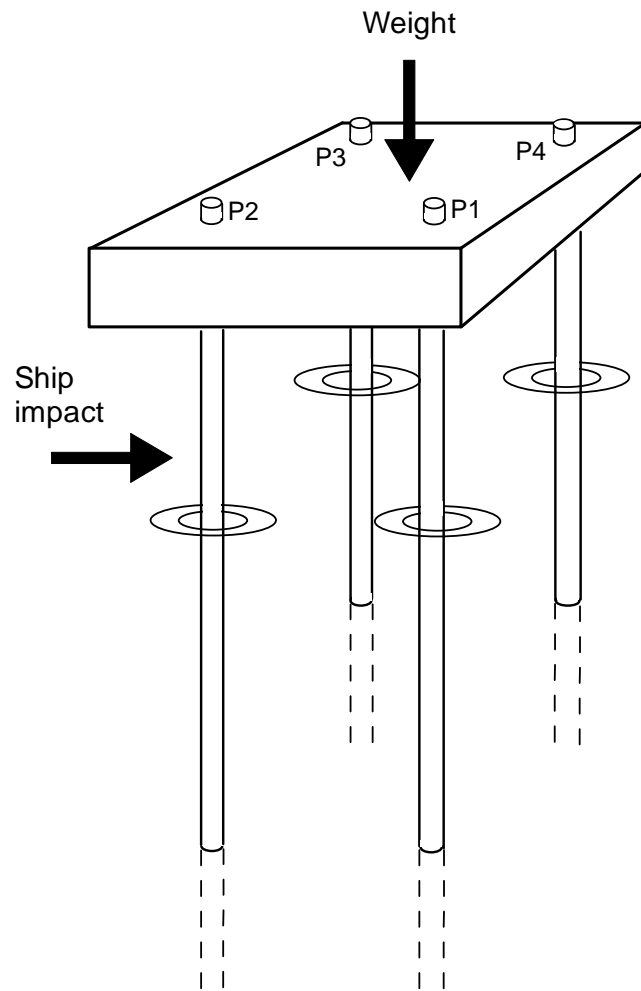
```
Proposed action  : Check that correct units are used  
                  Try to increase number of pile elements
```

# New SPLICE Summary Output

Pile	MAXIMUM PILE STRESSES			MAXIMUM X-SCTN UTILIZATION RATIO			RESERVE AXIAL FACTOR OF SAFETY			
	Node	Z	Sigma	Node	Z	UR(NORSOK)	Force	Capacity	FoS	
1	1	0.000	198.3	1	0.000	0.521	6.769E+03	2.498E+04	3.69	
2	1	0.000	165.6	1	0.000	0.430	4.536E+03	2.485E+04	5.48	
3	1	0.000	-158.6	1	0.000	0.366	-2.243E+03	-1.292E+04	5.76	
4	1	0.000	134.7	1	0.000	0.336	4.939E+02	2.498E+04	50.57	
5	1	0.000	222.7	1	0.000	0.595	1.954E+04	3.413E+04	1.75	
6	1	0.000	213.2	1	0.000	0.567	1.759E+04	3.413E+04	1.94	
7	1	0.000	151.5	1	0.000	0.403	1.248E+04	3.397E+04	2.72	
8	1	0.000	-117.0	1	0.000	0.279	-1.299E+03	-1.614E+04	12.43	
9	1	0.000	-182.4	1	0.000	0.386	-1.164E+04	-1.614E+04	1.39	
10	1	0.000	-174.8	1	0.000	0.373	-1.039E+04	-1.614E+04	1.55	
11	1	0.000	-115.2	1	0.000	0.258	-3.989E+03	-1.627E+04	4.08	
12	1	0.000	134.3	1	0.000	0.352	9.076E+03	3.413E+04	3.76	
Max/min values =			222.7 (MPa)			0.595	Comp Tens	1.954E+04 -1.164E+04	3.413E+04 -1.614E+04	1.75 1.39



# Non-linear Pile Cross Sections, Include?



## Non-linearities due to:

- \* Axial capacity in soil (OK)
- \* Lateral capacity in soil (OK)
- \* Cross section capacity, N-M diagram (prepared)
- \* Code required eccentricity  $e$ ,  $M=N*e$  (prepared)
- \* Column buckling of non-supported pile (OK)