

**REPORT OF PDA & DLT ON 1 PILE,
St. RAPHAEL PROJECT**

23 August 2021

Client :
Reference nr :

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1 Introduction

This report contains the preliminary evaluation of the PDA (Pile Driving Analysis) measurements on 1 Steel pile. The PDA-test took place of 27th of June 2013 and has been carried out by the company xxxxx

The piles have been driven by a Delmag D22 Diesel Hammer.

To determine the ultimate bearing capacity of the pile a DLT (Dynamic Load Test) is recommended after a set up period of at least 3 days. The Dynamic Bearing Capacity and the Static Bearing Capacity of the piles have been determined using the Case method.

2 Project information

The project location is situated in

Fig 2.1 General impression of test location at

3 Soil Investigation

The available soil investigation consists out of a single dilatometer test and soil samples. The location is marked in Figure 2.1. The complete test information is enclosed in appendix A.

4 Hammer Cushion and pile information

The Pile has been partly driven by a Vibratory hammer up to a depth of 6.75m after this procedure the pile has been driven by a Delmag D22 Diesel Hammer. The pile type which has been used is circular steel pile. In the following table (4.1) an overview is given of the pile information.

| Table 4.1 Pile information | | | |
|-------------------------------|---|------------------------|-----------------------------------|
| Number | Dimensions Diameter and Length | Elasticity mode MPa | Mass density kg/m ³ |
| 1 Test | Ø 914 mm x 14.3 m (wall thickness 11 mm) | 210 | 7800.00 |



Fig 4.1 Impression of the Pile and project location



Fig 4.2 sensor mounting

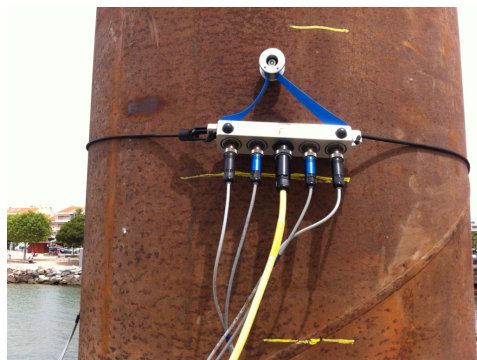


Fig 4.3 mounting of junctionbox

5 Measuring equipment

The PDA measurements have been performed with a Profound PDA system (Fig. 2) .

Two combined acceleration strain transducers (Fig.3) have been mounted at 2 m from the pile top. The applied acceleration transducers are piezo-resistive. The calibration certificates of the sensors are presented in appendix B.



Fig. 5.1 PDA USB conditioner and laptop



Fig.5.2 Combined acceleration-strain transducer

The strain and acceleration signals are transferred to a signal conditioning unit, digitised and transferred to force and velocity signals. During driving all measured hammer blows are recorded on hard disk and the measurement results presented on the lap-top screen.

6 Measuring results

In the table below the Pile driving Analysis Results are presented. The detailed results with graphical output are presented in chapter 5 and 6.

6.1 Summary of the measurements.

| Table 6.1 Summary of the tests | | |
|-----------------------------------|------------------------------------|------------------------|
| Pile No | Measurement log (Date and time) | Setup period (Days) |
| 1 | PDA 27-06-2013 | - |
| 2 | DLT 02-07-2013 | 4 |

| Table 6.2 Pile Driving Analysis Results (PDA) | | | |
|--|--|---|---------------------------------------|
| Pile No | Maximum Compression At measuring level MPa | Maximum Compression In the pile MPa | Maximum Tension In the pile MPa |
| 1 | 108 | 108 | 13 |

| Table 6.3 Dynamic Load Testing Results (DLT) | | |
|---|--------------------------------|-----------------------------------|
| Pile No | Total Driving Resistance MN | Mobilised Static Resistance MN |
| 1 | 5.7 | 3.7 |

6.2 Sensor parameters

```

GENERAL TRANSDUCER DATA
Cable length                                     :40.000 [m]

SIGNAL TYPES
Accelerations and strains = 1
Velocities and strains   = 2                       :1

DATA ACCELERATION TRANSDUCERS

ACCELERATION TRANSDUCER CHANNEL 1
Serial number acceleration transducer channel 1 :AC1038
Calibration factor acc. transd. channel 1      :0.0253 [mV/g]
(Excitation voltage 10V)
ACCELERATION TRANSDUCER CHANNEL 2
Serial number acceleration transducer channel 2 :AC1039
Calibration factor acc. transd. channel 2:    :0.0256[mV/g]
(Excitation voltage 10V)
GENERAL DATA ACCELERATION TRANSDUCERS
Distance accel. transducers from pile top     :2.000[m]
Smoothing value acceleration signals          :30

DATA STRAIN TRANSDUCERS

STRAIN TRANSDUCER CHANNEL 3
Serial number strain transducer channel 3:     :ST1041
Calibration factor strain transducer channel 3 :3.90
Cable type (1 = YELLOW AWY16, 2 = RED AWR4    :1
           3 = BLACK AWB4 , 4 = BLACK AWB16
           5 = YELLOW UWY16)

STRAIN TRANSDUCER CHANNEL 4
Serial number strain transducer channel 4     :ST1042

Calibration factor strain transducer channel 4 :4.16
Cable type (1 = YELLOW AWY16, 2 = RED AWR4    :1
           3 = BLACK AWB4 , 4 = BLACK AWB16
           5 = YELLOW UWY16)

GENERAL DATA STRAIN TRANSDUCERS
Distance strain transducers from pile top     :2.000 m
Smoothing value strain signals                :30

```

SIGNAL PROCESSING DATA

Scaling of force and velocity x impedance
No scaling = 0
Automatic scaling velocity to force = 1
Automatic scaling force to velocity = 2
Manual input scaling factor = 3 :1
Sample time in microseconds :20

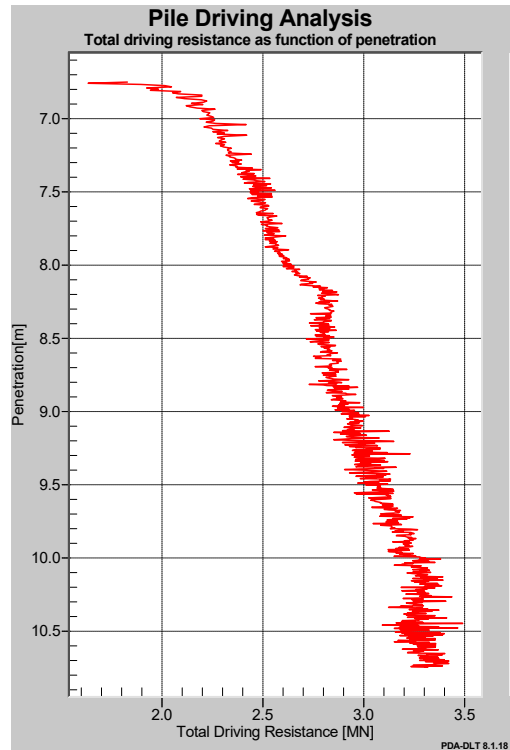
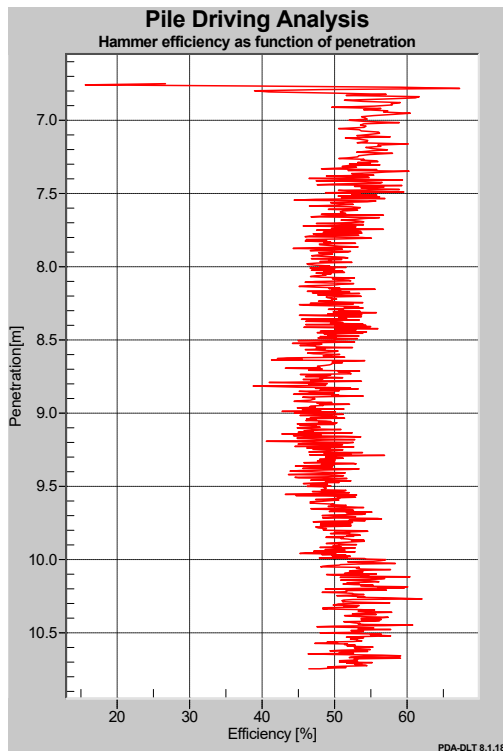
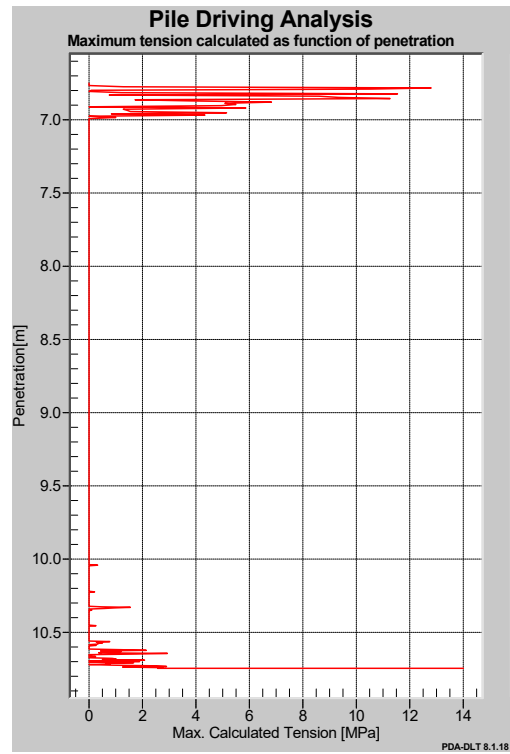
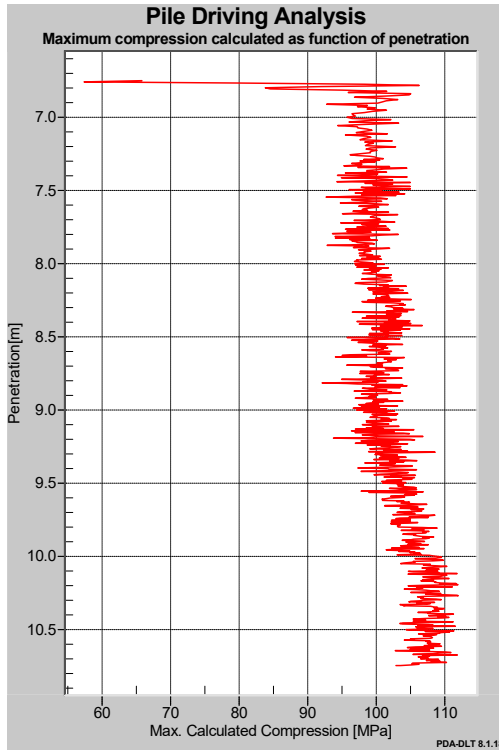
GENERAL DATA

Test date :27-06-2013
Site name :Port de St Raphael
Site location :St Raphael France
SPT contractor :
Client's name :RAZEL/BEC - CARI
Client's address :
City :
Country :France
Name of operator :G. BOULLENOIS
Type of pile driving hammer :Delmag D22
Rated energy hammer :38.0 [kJ]

PILE DATA

File type :open end pile
File number :test frejus 270613
Length below measuring level :12.300 [m]
Inclination (tan of angle with vertical) :0.000 [-]
Modulus of elasticity :210.000 [MPa]
Stress wave velocity :5188.745 [m/s]
Cross section type : Open Ended Pipe Pile
Outer pile diameter :0.914 [m]
Wall thickness :11.0 [mm]
Cross sectional area pile :0.0312 [m²]
Perimeter pile :2.8714 [m]
Outer pile diameter toe :0.914 [m]
Cross sectional area pile toe :31205.4 [m²]
Tension alarm level :0 [MPa]
Compression alarm level :0 [MPa]

6.3 Graphical results of PDA test



6.4 Graphical results of DLT

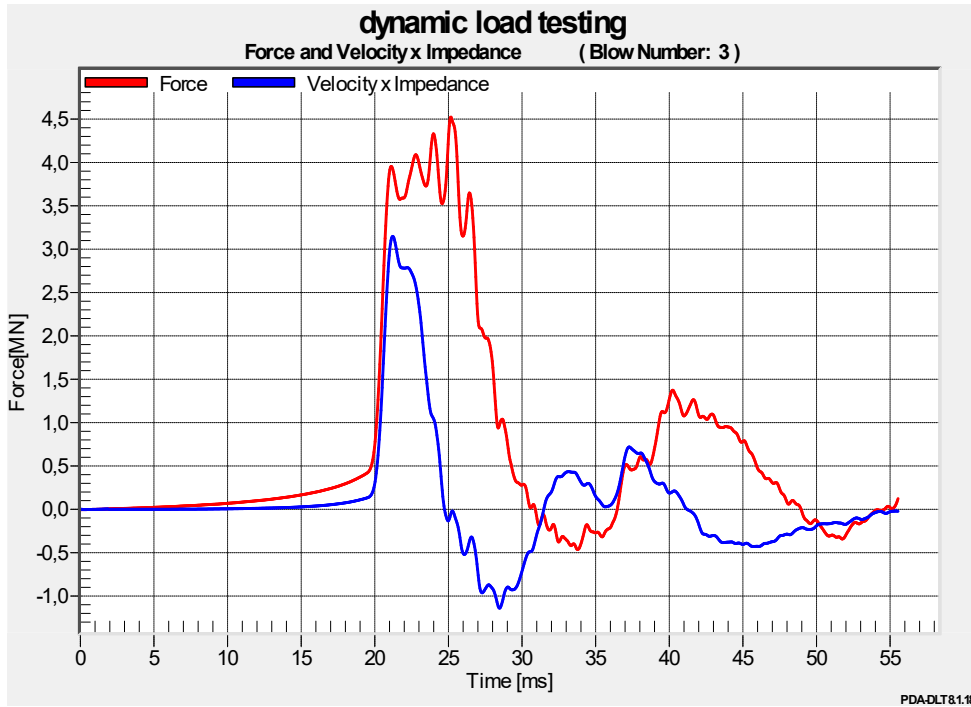


Figure 6.4.1 F Vz Graph of pile 1

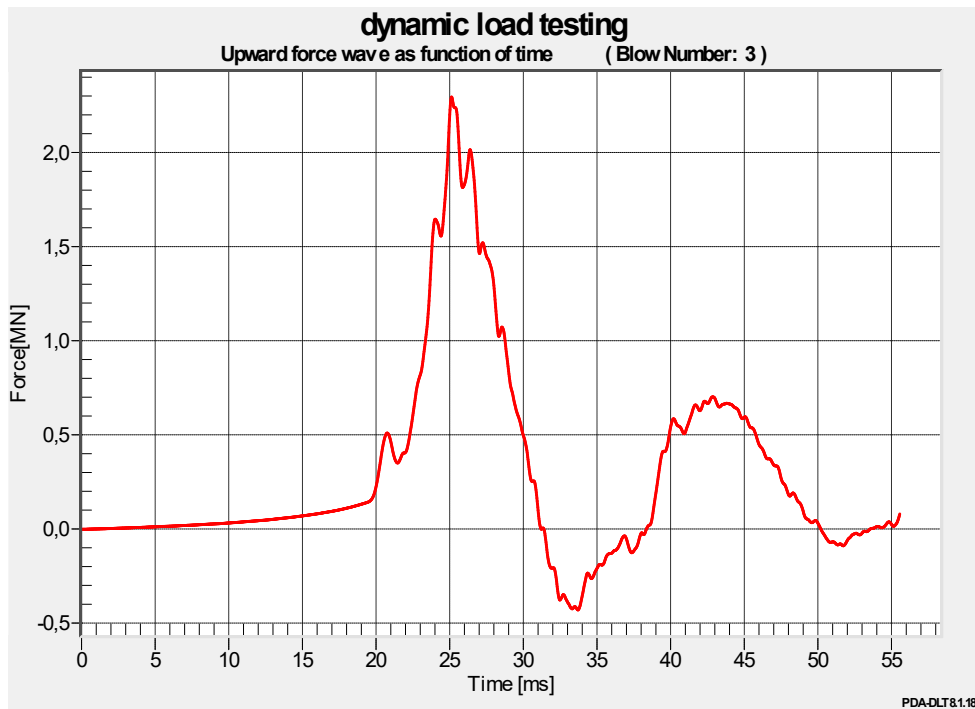


Figure 6.4.2 Upward wave

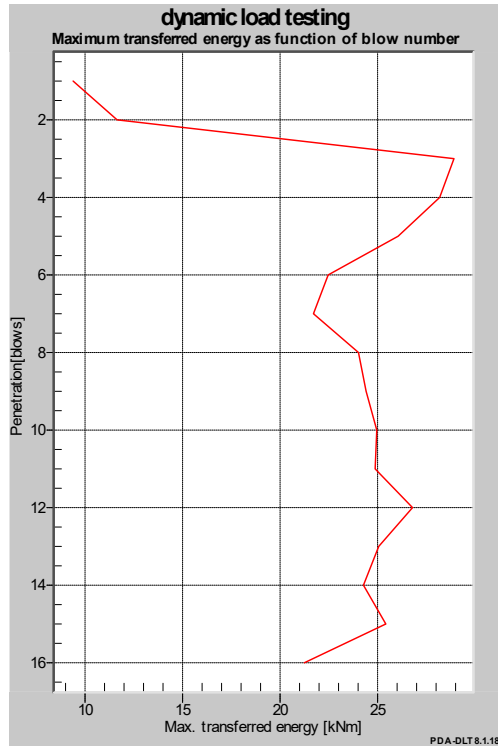


Fig 6.4.3

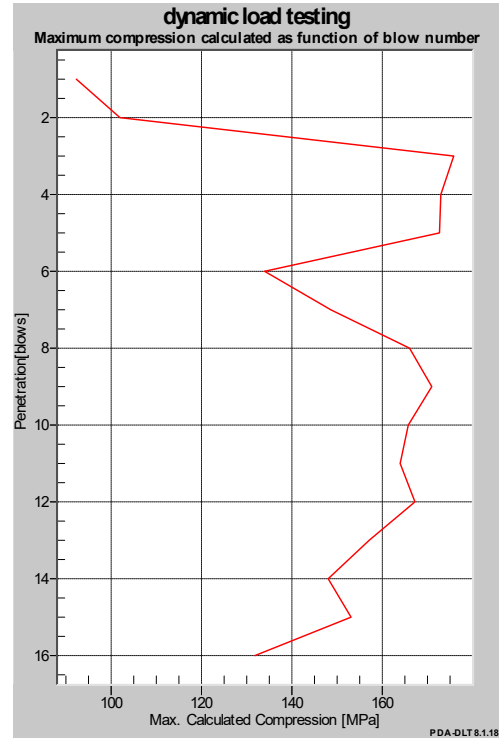


Fig 6.4.4

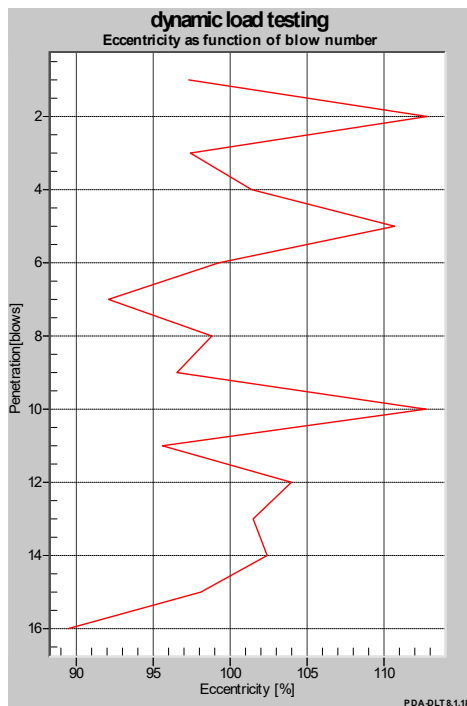


Fig 6.4.5

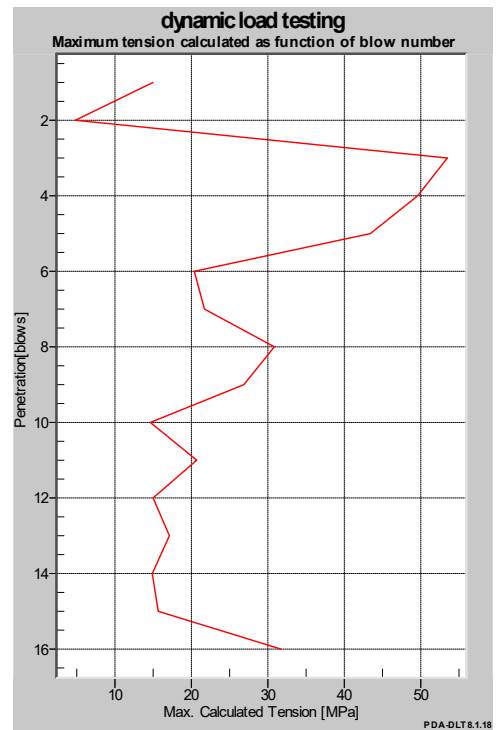


Fig 6.4.6

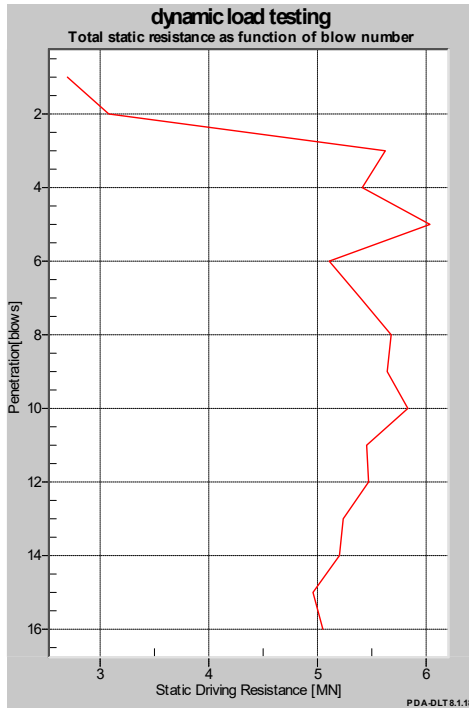


Fig 6.4.7

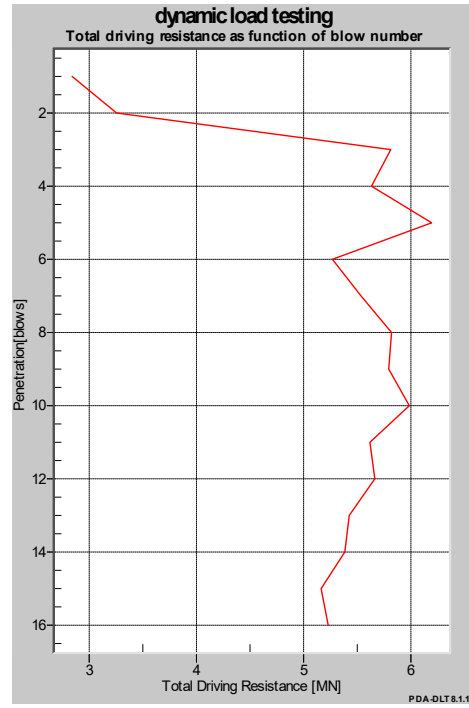
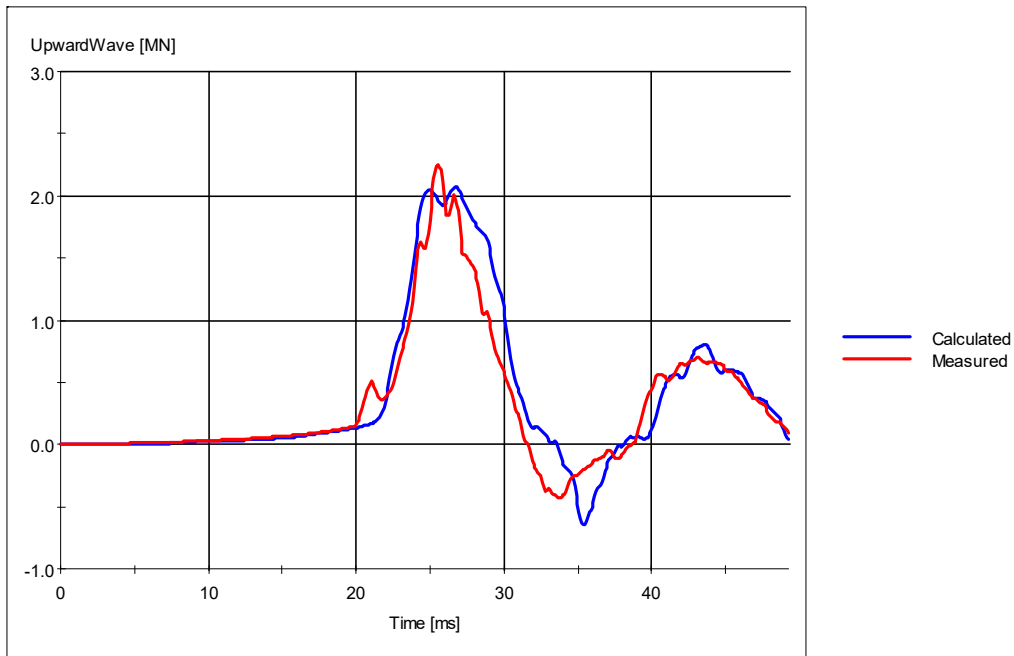


Fig 6.4.8

6.5 Graphical results of DLTwave signal match



UpwardWave as function of Time at level = 0.000

DLTWAVE Version 8.1.73

Fig 6.5.1 Signal matching result based on blow no. 3

APPENDIX A
Calibration Sheets

(Copies)

Calibration Certificate

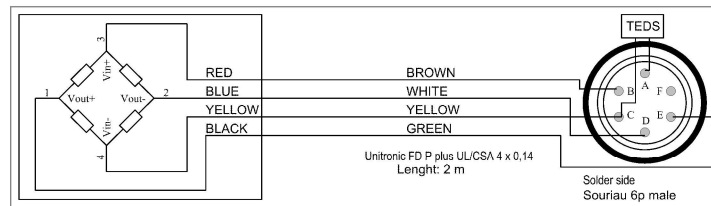
Strain sensor

Serial No. : ST1041

Technical data:

Strain range : 0...1500 $\mu\text{m/m}$
 Bridge resistance : 350 Ohm
 Strain gauges : 4 foil gages TML FLA-2.350-11
 Insulation resistance : >10 GOhm
 Cable : UNITRONIC FD P plus 4x0.14

Wiring:



Calibration data:

Static Calibration number : 3,90

Sensitivity (S) : 1,95 $\mu\text{V/V} \cdot \mu\text{Strain}$
 Zero load output : -26,2 $\mu\text{V/Volt}$

Date Engineer J.V.Ledderhof Signature

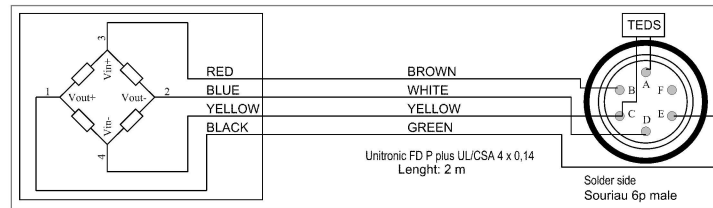
Calibration Certificate

Strain sensor

Serial No. : ST1042

Technical data:

Strain range : 0...1500 $\mu\text{m/m}$
 Bridge resistance : 350 Ohm
 Strain gauges : 4 foil gages TML FLA-2.350-11
 Insulation resistance : >10 GOhm
 Cable : UNITRONIC FD P plus 4x0.14



Wiring:

Calibration data:

Static Calibration number : 3,84

Sensitivity (S) : 1,92 $\mu\text{V/V} \cdot \mu\text{Strain}$
 Zero load output : 48,7 $\mu\text{V/Volt}$

Date Engineer J.V.Ledderhof Signature

CALIBRATION AND SPECIFICATION ACCELERATION TRANSDUCER

| | |
|----------------------------------|------------------------|
| Transducer Identification | |
| Manufacture | MEAS France |
| Model | EGCS-S055B-5000 |
| Serial Number | AC1038 |

| | | |
|-------------------------|-------------------|-------------|
| Electrical Test | | |
| Zero [typ.] | +/- 5 | [mV] |
| Excitation | 10 | [V] |
| Input impedance | 1694 | [Ω] |
| Output impedance | 915 | [Ω] |
| Operating range | -40 to 120 | [°C] |

| | |
|------------------------------------|---|
| Calibration | |
| Sensitivity @ 1000g, 700 Hz | 0.0253 [mV/g] |
| Calibration equipment | Traceable to a National Standard |
| Calibration date: | 20-06-2013 |
| Calibrated by | MEAS France |

| Wiring | | | Connector Souriau 851 06E 106 P66 |
|-----------------|-------------------|---------------|--|
| | Transducer | Cable | |
| Input + | Red | Brown | Input + Terminal B |
| Input - | Black | Yellow | Input - Terminal C |
| Output + | Green | Green | Output + Terminal E |

| | | | |
|----------|-------|-------|---------------------|
| Output - | White | White | Output - Terminal D |
|----------|-------|-------|---------------------|

CALIBRATION AND SPECIFICATION ACCELERATION TRANSDUCER

| | |
|----------------------------------|------------------------|
| Transducer Identification | |
| Manufacture | MEAS France |
| Model | EGCS-S055B-5000 |
| Serial Number | AC1039 |

| | |
|-------------------------|------------------------|
| Electrical Test | |
| Zero [typ.] | +/- 5 [mV] |
| Excitation | 10 [V] |
| Input impedance | 1695 [Ω] |
| Output impedance | 914 [Ω] |
| Operating range | -40 to 120 [°C] |

| | |
|------------------------------------|---|
| Calibration | |
| Sensitivity @ 1000g, 700 Hz | 0.0256 [mV/g] |
| Calibration equipment | Traceable to a National Standard |
| Calibration date: | 20-06-2013 |
| Calibrated by | MEAS France |

| | | | |
|----------------|-------------------|---------------|--|
| Wiring | | | Connector Souriau 851 06E 106 P66 |
| | Transducer | Cable | |
| Input + | Red | Brown | Input + Terminal B |
| Input - | Black | Yellow | Input - Terminal C |

| | | | |
|-----------------|--------------|--------------|----------------------------|
| Output + | Green | Green | Output + Terminal E |
| Output - | White | White | Output - Terminal D |

APPENDIX B

Soil investigation data

APPENDIX C

Numerical input and output

Input Data
Dimensions Data

| Part | Number | Type | D/B_top [m] | D/B_bottom [m] | Wall Th. [mm] | Length |
|------|--------|-------------|----------------|-------------------|------------------|--------|
| Pile | 1 | Casing Open | 0,9140 | 0,9140 | 11,0 | 12,800 |

Material Data

| Part | Number | E - Modulus [MPa] | Density [kg/m3] |
|------|--------|-------------------------|--------------------|
| Pile | 1 | 210000 | 7800 |

Soil investigation data

| Layer No. | Level | Depth [m] | Thick ness [m] | Cone Resist. [MPa] | Shaft Friction [KPa] | Friction Ratio [%] | Soil Type [-] |
|-----------|--------|--------------|----------------------|--------------------------|----------------------------|--------------------------|---------------------|
| 1 | Top | 0,000 | 1,000 | 0 | 0,0 | 0,000 | Sand |
| | Bottom | -1,000 | | 1 | 6,5 | 0,500 | |
| 2 | Top | -1,000 | 1,500 | 1 | 6,5 | 0,500 | Sand |
| | Bottom | -2,500 | | 5 | 23,0 | 0,500 | |
| 3 | Top | -2,500 | 1,500 | 5 | 23,0 | 0,500 | Sand |
| | Bottom | -4,000 | | 3 | 14,5 | 0,500 | |
| 4 | Top | -4,000 | 1,500 | 3 | 14,5 | 0,500 | Sand |
| | Bottom | -5,500 | | 4 | 21,5 | 0,500 | |
| 5 | Top | -5,500 | 1,500 | 4 | 21,5 | 0,500 | Sand |
| | Bottom | -7,000 | | 15 | 75,5 | 0,500 | |
| 6 | Top | -7,000 | 1,500 | 15 | 75,5 | 0,500 | Sand |
| | Bottom | -8,500 | | 1 | 4,5 | 0,500 | |
| 7 | Top | -8,500 | 1,500 | 1 | 4,5 | 0,500 | Sand |
| | Bottom | -10,000 | | 1 | 4,5 | 0,500 | |
| 8 | Top | -10,000 | 1,500 | 1 | 4,5 | 0,500 | Sand |
| | Bottom | -11,500 | | 9 | 42,5 | 0,500 | |
| 9 | Top | -11,500 | 1,500 | 9 | 42,5 | 0,500 | Sand |
| | Bottom | -13,000 | | 6 | 29,5 | 0,500 | |
| 10 | Top | -13,000 | 1,500 | 6 | 29,5 | 0,500 | Sand |
| | Bottom | -14,500 | | 18 | 89,3 | 0,500 | |
| 11 | Top | -14,500 | 1,500 | 12 | 238,0 | 2,000 | Stiff clay |
| | Bottom | -16,000 | | 6 | 112,0 | 2,000 | |
| 12 | Top | -16,000 | 1,500 | 6 | 112,0 | 2,000 | Stiff clay |
| | Bottom | -17,500 | | 4 | 84,0 | 2,000 | |
| 13 | Top | -17,500 | 1,500 | 4 | 84,0 | 2,000 | Stiff clay |
| | Bottom | -19,000 | | 5 | 104,0 | 2,000 | |
| 14 | Top | -19,000 | 19,500 | 5 | 104,0 | 2,000 | Stiff clay |
| | Bottom | -38,500 | | 0 | 0,0 | 0,000 | |

Shaft soil model input
Soil Model = Smith Model

| Layer No. | Level | Depth [m] | Yield stress [KPa] | Uq1 [mm] | Uq2 [mm] | Yield factor | Beta | Js [1/s] | Alfa | Inner fr.fact. | Outer fr.fact. |
|-----------|--------|--------------|--------------------------|-------------|-------------|-----------------|-------|-------------|-------|-------------------|-------------------|
| | Top | 0,000 | 0,0 | 2,0 | 2,0 | 1,000 | 1,000 | 1,452 | 1,000 | 1,000 | 1,000 |
| | Bottom | -1,000 | 27,2 | 2,0 | 2,0 | 1,000 | 1,000 | 0,579 | 1,000 | 1,000 | 1,000 |
| | Top | -1,000 | 101,4 | 2,0 | 2,0 | 1,000 | 1,000 | 0,645 | 1,000 | 1,000 | 1,000 |
| | Bottom | -2,500 | 132,5 | 2,0 | 2,0 | 1,000 | 1,000 | 0,576 | 1,000 | 1,000 | 1,000 |
| | Top | -2,500 | 27,8 | 2,0 | 2,0 | 1,000 | 1,000 | 0,107 | 1,000 | 1,000 | 1,000 |
| | Bottom | -4,000 | 16,2 | 2,0 | 2,0 | 1,000 | 1,000 | 0,114 | 1,000 | 1,000 | 1,000 |
| | Top | -4,000 | 98,2 | 2,0 | 2,0 | 1,000 | 1,000 | 1,738 | 1,000 | 1,000 | 1,000 |
| | Bottom | -5,500 | 21,2 | 2,0 | 2,0 | 1,000 | 1,000 | 0,848 | 1,000 | 1,000 | 1,000 |
| | Top | -5,500 | 22,0 | 2,0 | 2,0 | 1,000 | 1,000 | 0,597 | 1,000 | 1,000 | 1,000 |
| | Bottom | -7,000 | 483,5 | 2,0 | 2,0 | 1,000 | 1,000 | 0,902 | 1,000 | 1,000 | 1,000 |
| | Top | -7,000 | 302,0 | 2,0 | 2,0 | 1,000 | 1,000 | 0,802 | 1,000 | 1,000 | 1,000 |
| | Bottom | -8,500 | 30,6 | 2,0 | 2,0 | 1,000 | 1,000 | 0,548 | 1,000 | 1,000 | 1,000 |
| | Top | -8,500 | 9,5 | 2,0 | 2,0 | 1,000 | 1,000 | 1,152 | 1,000 | 1,000 | 1,000 |
| | Bottom | -10,000 | 30,2 | 2,0 | 2,0 | 1,000 | 1,000 | 0,810 | 1,000 | 1,000 | 1,000 |
| | Top | -10,000 | 7,3 | 2,0 | 2,0 | 1,000 | 1,000 | 0,338 | 1,000 | 1,000 | 1,000 |
| | Bottom | -11,500 | 197,1 | 2,0 | 2,0 | 1,000 | 1,000 | 0,623 | 1,000 | 1,000 | 1,000 |
| | Top | -11,500 | 170,0 | 2,0 | 2,0 | 1,000 | 1,000 | 0,400 | 1,000 | 1,000 | 1,000 |
| | Bottom | -13,000 | 118,0 | 2,0 | 2,0 | 1,000 | 1,000 | 0,400 | 1,000 | 1,000 | 1,000 |
| | Top | -13,000 | 118,0 | 2,0 | 2,0 | 1,000 | 1,000 | 0,400 | 1,000 | 1,000 | 1,000 |
| | Bottom | -14,500 | 357,0 | 2,0 | 2,0 | 1,000 | 1,000 | 0,400 | 1,000 | 1,000 | 1,000 |
| | Top | -14,500 | 952,0 | 2,0 | 2,0 | 1,000 | 1,000 | 2,000 | 0,200 | 1,000 | 1,000 |
| | Bottom | -16,000 | 448,0 | 2,0 | 2,0 | 1,000 | 1,000 | 2,000 | 0,200 | 1,000 | 1,000 |
| | Top | -16,000 | 448,0 | 2,0 | 2,0 | 1,000 | 1,000 | 2,000 | 0,200 | 1,000 | 1,000 |
| | Bottom | -17,500 | 336,0 | 2,0 | 2,0 | 1,000 | 1,000 | 2,000 | 0,200 | 1,000 | 1,000 |
| | Top | -17,500 | 336,0 | 2,0 | 2,0 | 1,000 | 1,000 | 2,000 | 0,200 | 1,000 | 1,000 |

| | | | | | | | | | | |
|--------|---------|-------|-----|-----|-------|-------|-------|-------|-------|-------|
| Bottom | -19,000 | 416,0 | 2,0 | 2,0 | 1,000 | 1,000 | 2,000 | 0,200 | | |
| Top | -19,000 | 416,0 | 2,0 | 2,0 | 1,000 | 1,000 | 2,000 | 0,200 | 1,000 | 1,000 |
| Bottom | -38,500 | 0,0 | 2,0 | 2,0 | 1,000 | 1,000 | 2,000 | 0,200 | | |

Toe soil model input

Soil Model = Smith Model

| Layer No. | Level | Depth [m] | Yield stress [MPa] | Uq1 [mm] | Uq2 [mm] | Yield factor | Beta | Js [1/s] | Alfa |
|-----------|--------|-----------|--------------------|----------|----------|--------------|-------|----------|-------|
| | Top | -10,000 | 2 | 2,0 | 2,0 | 0,100 | 1,000 | 0,225 | 1,000 |
| | Bottom | -11,500 | 2 | 2,0 | 2,0 | 0,100 | 1,000 | 0,225 | 1,000 |

Output Data

| | | |
|-----------------------------------|-------|------|
| Total mobilised static resistance | 3.742 | [MN] |
| Static mobilised shaft resistance | 2.643 | [MN] |
| Static mobilised toe resistance | 1.099 | [MN] |

Modelled and mobilised static resistance

| Layer | Depth [m] | Modelled Res. [MN] | Mobilised Res. [MN] |
|-------|-----------|--------------------|---------------------|
| 1 | 0.000 | 0.029 | 0.029 |
| 2 | -1.000 | 0.567 | 0.567 |
| 3 | -2.500 | 0.086 | 0.086 |
| 4 | -4.000 | 0.324 | 0.324 |
| 5 | -5.500 | 1.034 | 1.034 |
| 6 | -7.000 | 0.516 | 0.516 |
| 7 | -8.500 | 0.055 | 0.055 |
| 8 | -10.000 | 0.033 | 0.033 |
| 9 | -11.500 | 0.000 | 0.000 |
| 10 | -13.000 | 0.000 | 0.000 |
| 11 | -14.500 | 0.000 | 0.000 |
| 12 | -16.000 | 0.000 | 0.000 |
| 13 | -17.500 | 0.000 | 0.000 |
| 14 | -19.000 | 0.000 | 0.000 |
| ----- | | | |
| Shaft | | 2.643 | 2.643 [MN] |
| Toe | | 1.099 | 1.099 [MN] |
| ----- | | | |
| Total | | 3.742 | 3.742 [MN] |

Mobilised static resistance

| Layer | Depth [m] | Mobilised Res. [MN] |
|-------|-----------|---------------------|
| 1 | 0.000 | 0.029 |
| 2 | -1.000 | 0.567 |
| 3 | -2.500 | 0.086 |
| 4 | -4.000 | 0.324 |
| 5 | -5.500 | 1.034 |
| 6 | -7.000 | 0.516 |
| 7 | -8.500 | 0.055 |
| 8 | -10.000 | 0.033 |
| 9 | -11.500 | 0.000 |
| 10 | -13.000 | 0.000 |
| 11 | -14.500 | 0.000 |
| 12 | -16.000 | 0.000 |
| 13 | -17.500 | 0.000 |
| 14 | -19.000 | 0.000 |
| ----- | | |
| Shaft | | 2.643 [MN] |
| Toe | | 1.099 [MN] |
| ----- | | |
| Total | | 3.742 [MN] |