HATTI MENGAJAR

# UJI BEBAN FONDASI

(..... dari perspektif seorang) Aksan KAWANDA

2021.01.31


LIGHT RAIL TRANSIT
STATIC AXIAL LOAD TEST
BASED ON ASTM D1143-07 (re-13)
4400 Ton
adhi
OCG - JOPRISS
CIPTA GRAHA ABADI
Foundation Test by:
GEOTECH EFATHAMA
JABODEBEK
UNSEEN MEGASTRUCTURE


Right is right
THOUGH ALL CONDEMN,
&
wrong is wrong
THOUGH ALL APPROVE.
CHARLES SPURGEON


STA
TIK

# PENGUJIAN BEBAN STATIK

Pengujian beban untuk verifikasi daya dukung dan pergerakan yang terjadi pada tiang uji.

Pengujian ini dapat dilakukan dengan (3) metode :

- Beban mati / Kentledge
- Tiang reaksi
- Pembebanan Cell 2 Arah

# Standar Pengujian

ASTM INTERNATIONAL

D1143-07 (Re-13), Standard Test Method for Deep Foundations Under Static Axial Compression Load

D3689-07, Standard Test Method for Deep Foundations Under Static Axial Tensile Load

D3966-07, Standard Test Method for Deep Foundations Under Lateral Load

D8169-18, Standard Test Methods for Deep Foundation Under Bi-Directional Static Axial Compressive Load

SNI
Standar Nasional Indonesia

**SNI 8460-2017,**
**Persyaratan Perancangan Geoteknik**

# Standar Nasional Indonesia 8460:2017

Jumlah tiang uji

A. Tiang Bor, 1 tes = 75 tiang

B. Tiang Pancang, 1 tes = 100 tiang

C. Jika N<75 bor / <100 pancang min 1 tes

D. Ketentuan tambahan

a . N<1000, 1%N

b. 1000<N<3000, 0.8%N + item a

c. 3000<N<6000, 0.5%N + item b

d. 6000<N<8000, 0.4%N + item c

E. 60% Sebelum konstruksi, 40% saat konstruksi

# Standar Nasional Indonesia 8460:2017

Tiang Bor Total 8600

a. 1% x 1000 = 10
b. 0.8% x 2000 = 16
c. 0.5% x 3000 = 15
d. 0.4% x 2600 = 10.4 ≈ 11

Total Tes = 52 tiang

*60% Statik + 40% x 4 Dinamik (diperbolehkan)*

# Standar Nasional Indonesia 8460:2017

Jumlah tiang uji

- Axial Tarik
  - 1 tes = 100 tiang / min 1 (dimensi sama)
- Lateral
  - 1 tes setiap dimensi tiang

# Standar Nasional Indonesia 8460:2017

**Beban Uji (Tekan, Tarik, Lateral)**

- Used Pile, 200% beban rencana

Batasan Deformasi

- Axial Tekan
  - 25 mm, tiang ≤ 80 cm
  - 4% D, tiang > 80 cm
- Axial Tarik
  - PL/EA + 4mm / maks 25 mm
- Lateral
  - 100% 10 mm, 200% 25 mm

# Standar Nasional Indonesia 8460:2017

## Syarat Khusus

- Wajib Loadcell
- Lateral dan Tarik dilakukan pada C.O.L
- Tekan boleh tidak di C.O.L (Perlakuan khusus + koreksi friksi)
- Hasil uji tekan jika failure perlu interpretasi, jika masih elastis tidak perlu asalkan < batas deformasi
- Tiang uji tekan ≥ 6 ,boleh digunakan lagi untuk tiang uji lateral (max 2)

## Uji Beban Statik Aksial Tekan

# WHAT IS IT?

- Metode uji skala penuh pada fondasi tiang.
- Tujuan utama melakukan verifikasi kapasitas ultimit dan penurunan tiang.
- Pengujian dapat dilakukan dengan beberapa metode (tiang reaksi, beban mati, beban cell 2-arah).

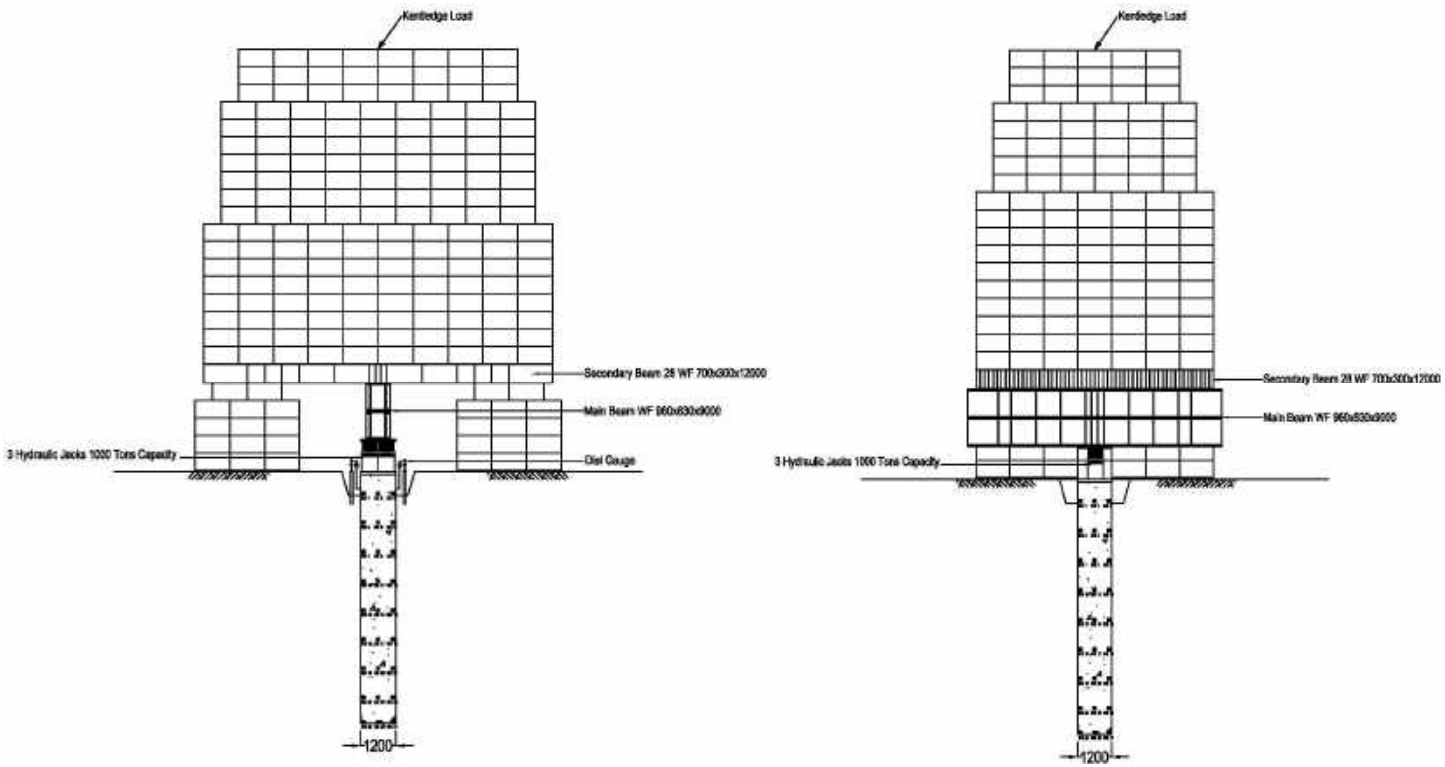
# Tipikal Uji Beban Statik

- Aksial Tekan
- Aksial Tarik
- Lateral


# Metode Beban Mati

1. Blok Beton
2. Tiang
3. HSPD
4. Beban Kontra

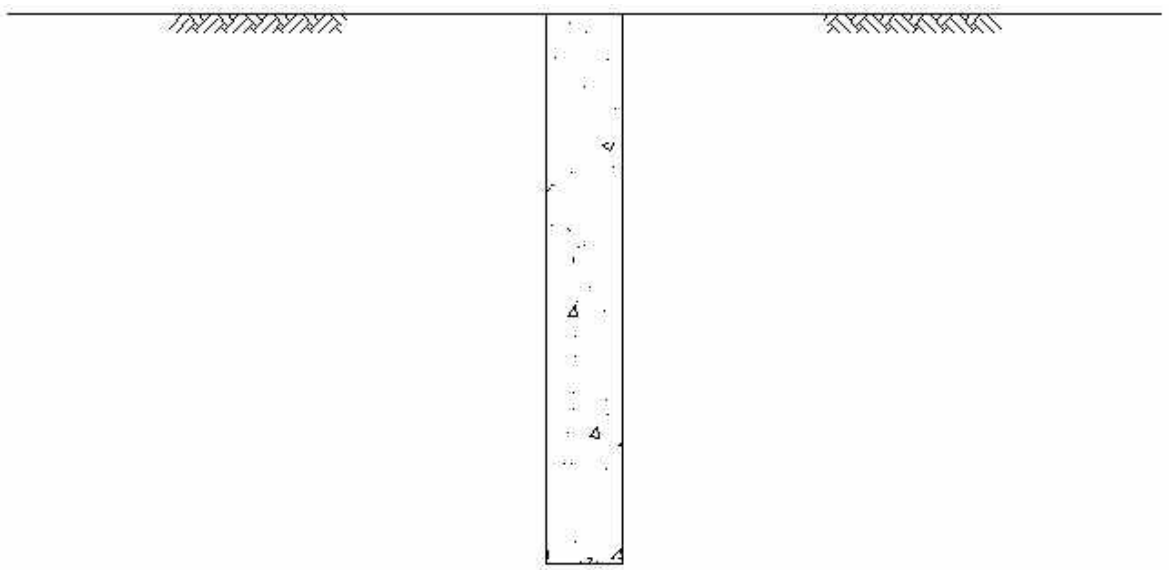
# Metode Beban Mati



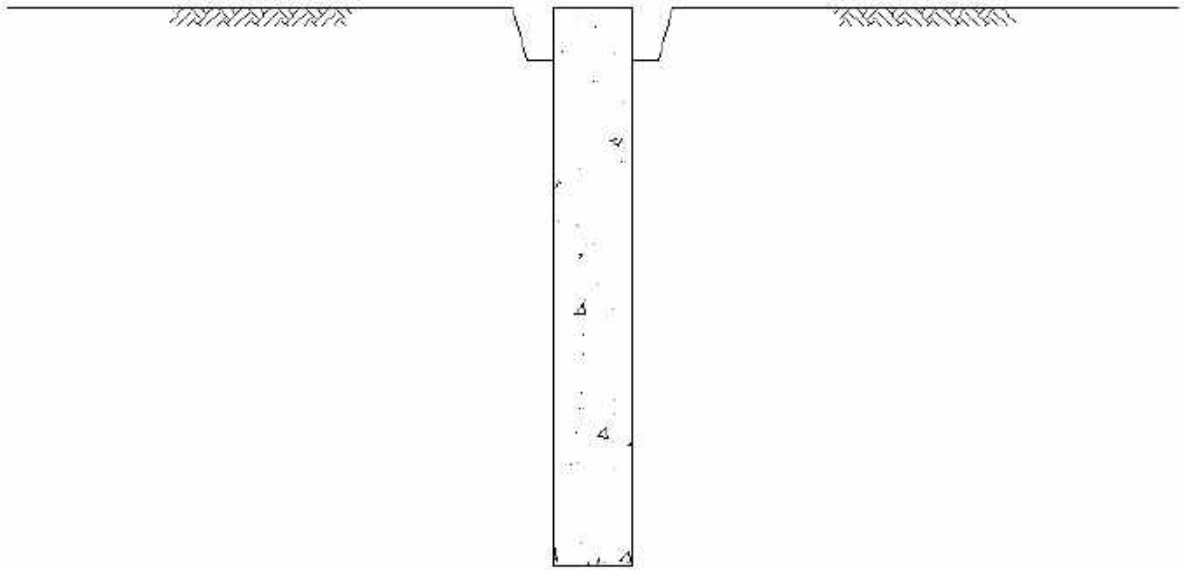
# LANGKAH-LANGKAH PENYUSUNAN UJI STATIK AKSIAL TEKAN

*(METODE KENTLEDGE)*

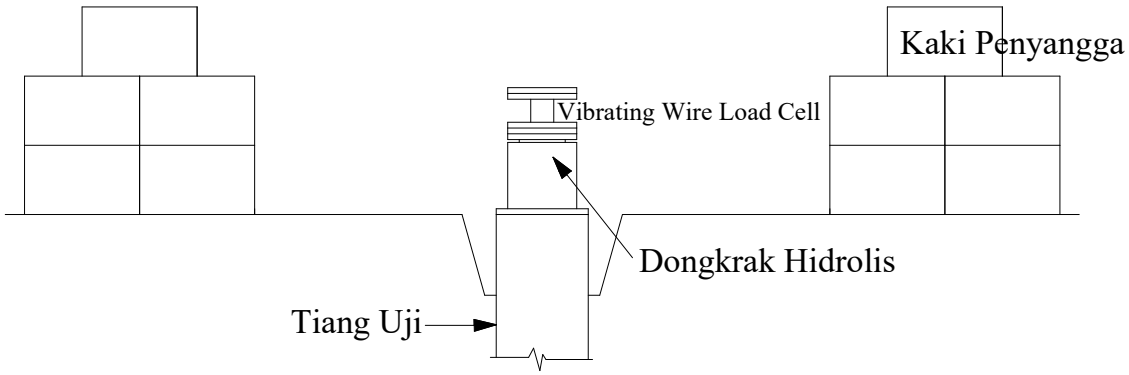
**Kondisi awal**



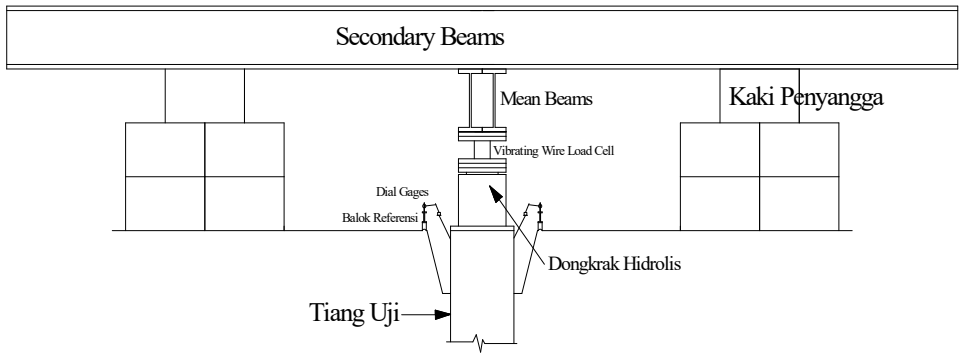
## Ekspos kepala tiang



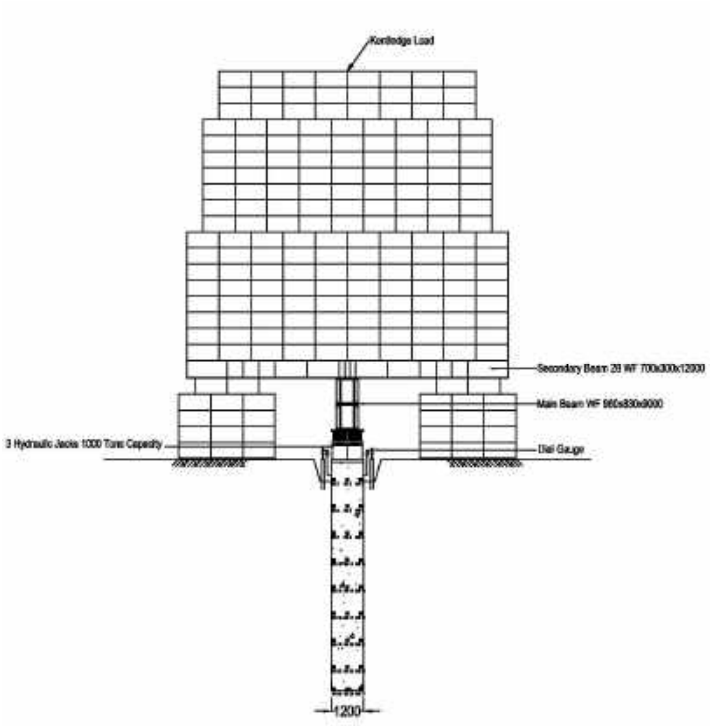
## Pemasangan Dongkrak Hidrolis dan VWLC

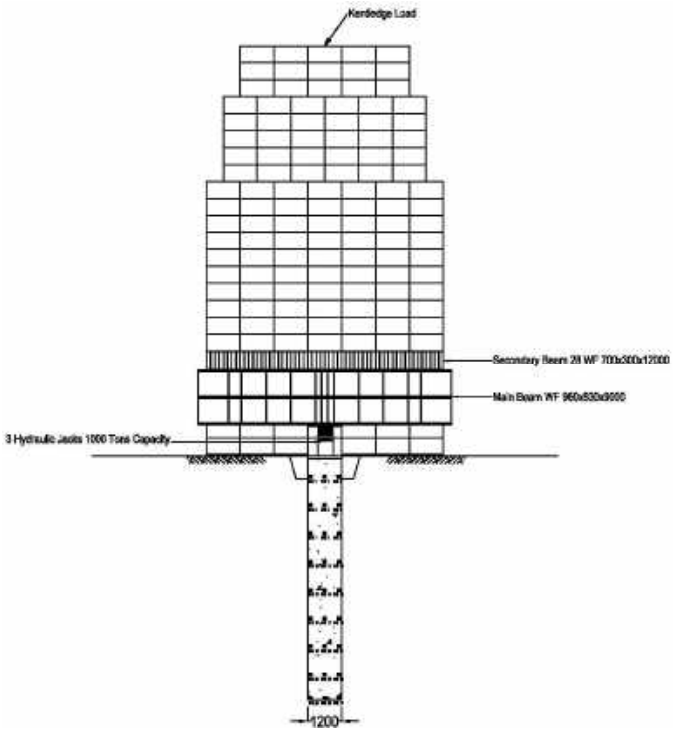


# Susun balok sekunder dan kaki penyangga



## Penyusunan akhir



# Metode Beban Mati

1. Kondisi awal
2. Kaki dan beban
3. Dongkrak, Load Cell, Balok Utama
4. Balok Sekunder
5. Beban


- P
- C patan ja
- B dari p
- T nm di k

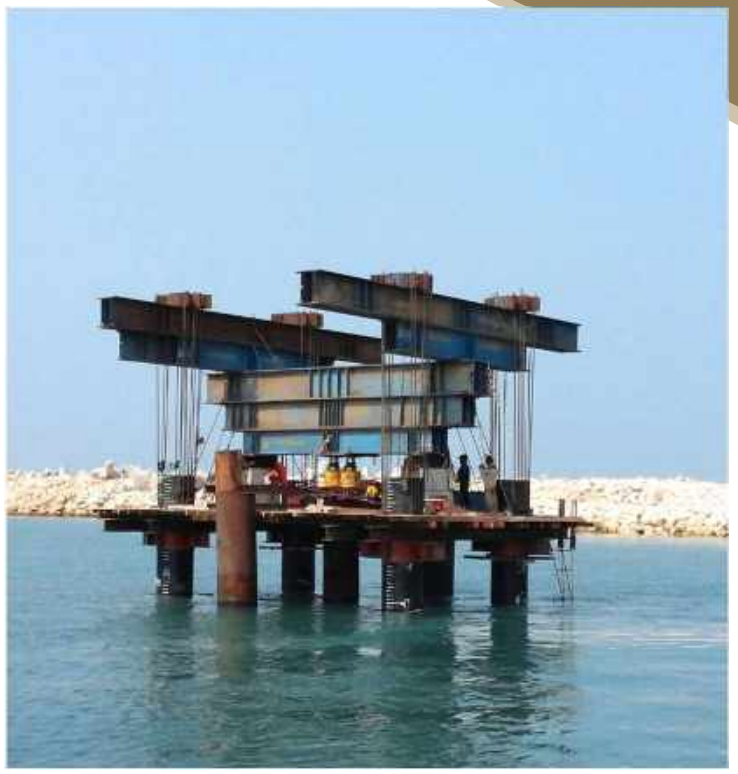
**Uji Beban Statik Aksial Tekan**

# Metode Kentledge

Beban mati yang diberikan WAJIB dilebihkan 10% dari beban uji maksimum

Uji Beban
Statik Aksial Tekan

# Metode Tiang Reaksi



**Uji Beban**
**Statik Aksial Tekan**

# Metode Tiang Reaksi

1. Kondisi Awal
2. Tampilkan Tiang
3. Pemasangan konektor
4. Pasang dongkrak & kaki penyangga
5. Persiapan Final

- B … yang
  s
- P
- E … akan
- B … ah
- P … n 25
  m

## Uji Beban Statik Aksial Tekan

# Peralatan

Hydraulic Jack

Pressure Gauge

Vibrating Wire Load Cell

# Standar Prosedur Pembebanan

- 1. Prosedur pembebanan Standar
- 2. Prosedur pembebanan Siklik
- 3. Prosedur pembebanan melebihi uji standar
- 4. Prosedur pembebanan dengan selang waktu tetap
- 5. Prosedur pembebanan dengan laju penetrasi tetap
- 6. Prosedur pembebanan cepat
- 7. Prosedur pembebanan dengan peningkatan penetrasi tetap

# Uji Beban Statik

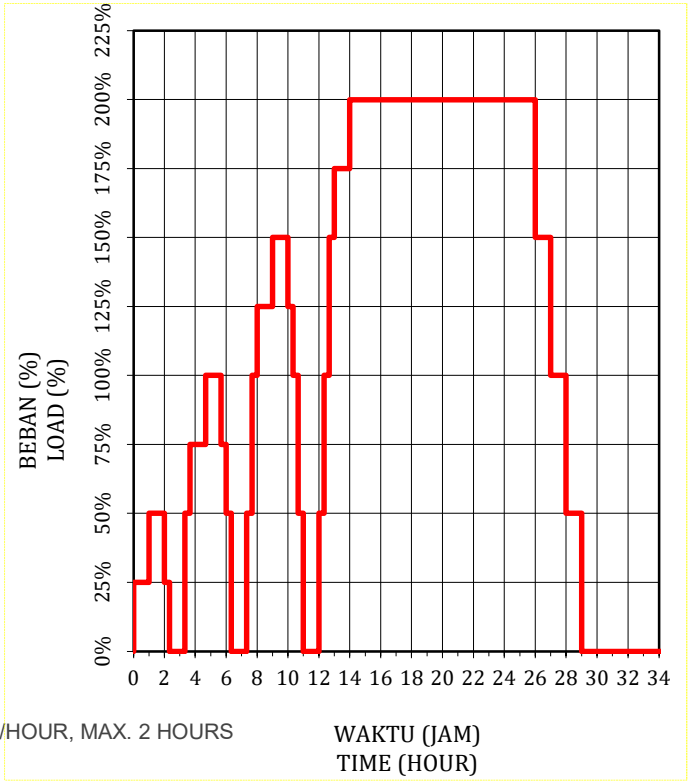
# Jadwal Pembebanan

BASED ON ASTM D1143-07

PROJECT :
LOCATION :
PROCEDURE : CYCLIC LOADING
DESIGN LOAD : 400TONS
MAX. TEST LOAD : 800TONS

CAPACITY OF HYD. JACK : 1000TONS

| CYCLE NO | PERCENT OF DESIGN LOAD | TEST LOAD (TONS) | LOAD SYMBOL | STEP OF LOADING IN MINUTES | CORELATION OIL PRESSURE & JACK FORCE PRODUES PSI | REMARK |
|---|---|---|---|---|---|---|
| I | 0 | 0 | - | 0 | 0 | |
| | 25 | 100 | A | 0-10-20-30-40-50-60-(-70-80-90-100-110-120) | 971 | Merk : ENERPAC - USA |
| | 50 | 200 | B | 0-10-20-30-40-50-60 | 1942 | Type : CLR - 10006 |
| | 25 | 100 | C | 0-10-20 | 971 | Capacity : 1000 TON |
| | 0 | 0 | B | 0-10-20-30-40-50-60 | 0 | |
| | | | | | | Cyl. Bor Dia. : 17.0" |
| II | 50 | 200 | C | 0-10-20 | 1942 | Cyl. Eff. Area : 227.0 sq. inch |
| | 75 | 300 | A | 0-10-20-30-40-50-60-(-70-80-90-100-110-120) | 2914 | 1 Lb : 453.6 gr |
| | 100 | 400 | B | 0-10-20-30-40-50-60 | 3885 | |
| | 75 | 300 | C | 0-10-20 | 2914 | 1000000 |
| | 50 | 200 | C | 0-10-20 | 1942 | 1 ton : ---------- |
| | 0 | 0 | B | 0-10-20-30-40-50-60 | 0 | 453.6 |
| | | | | | | |
| III | 50 | 200 | C | 0-10-20 | 1942 | : 2204.59 lbs |
| | 100 | 400 | C | 0-10-20 | 3885 | |
| | 125 | 500 | A | 0-10-20-30-40-50-60-(-70-80-90-100-110-120) | 4856 | 2204.59 |
| | 150 | 600 | B | 0-10-20-30-40-50-60 | 5827 | 1 ton : ---------- |
| | 125 | 500 | C | 0-10-20 | 4856 | 227.00 |
| | 100 | 400 | C | 0-10-20 | 3885 | |
| | 50 | 200 | C | 0-10-20 | 1942 | : 9.712 psi |
| | 0 | 0 | B | 0-10-20-30-40-50-60 | 0 | |
| | | | | | | |
| IV | 50 | 200 | C | 0-10-20 | 1942 | |
| | 100 | 400 | C | 0-10-20 | 3885 | |
| | 150 | 600 | C | 0-10-20 | 5827 | |
| | 175 | 700 | A | 0-10-20-30-40-50-60-(-70-80-90-100-110-120) | 6798 | |
| | 200 | 800 | D | 0-10-20-30-40-50-60-(-70-80-90-100-110-120) | 7769 | |
| | | | | And then every hour | | |
| | 150 | 600 | B | 0-10-20-30-40-50-60 | 5827 | |
| | 100 | 400 | B | 0-10-20-30-40-50-60 | 3885 | |
| | 50 | 200 | B | 0-10-20-30-40-50-60 | 1942 | |
| | 0 | 0 | E | 0-10-20-30-40-50-60-(-70-80-90-100-110-120) | 0 | |
| | | | | And then every hour | | |

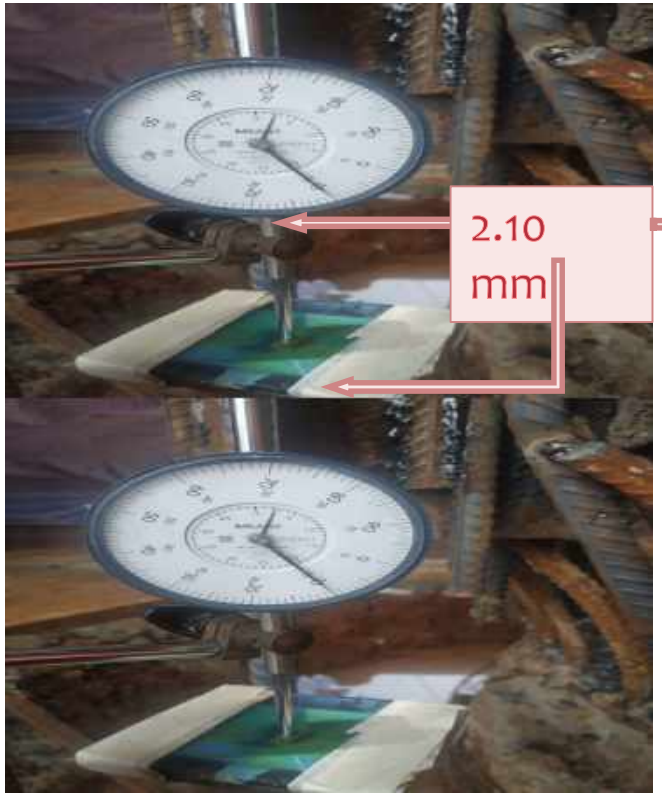



N O T E

A : 1 HOUR IF RATE OF SETT. <0.25 MM/HOUR, MAX. 2 HOURS
B : 1 HOURS
C : 20 MINUTES
D : 12 HOURS IF RATE OF SETT. <0.25 MM/HOUR, MAX. 24 HOURS
E : 2 HOURS UNTIL REBOUND < 0.25 MM/HOUR, MAX. 12 HOURS

## Uji Beban Statik

# Pencatatan Data




DIAL GAUGES RECORDING FORM

| Project | | | | Elevasi dasar tiang (m) | | | | | | | Sheet |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Location | | Pile No. | | Elevasi kepala tiang (m) | | | | | | | |
| Pile Dia. (mm) | 1200 | Testing Date | | COL (m) | | | | | | | |
| Working Load (Ton) | 234 | Test Load (Ton) | 468 | Panjang Tiang (m) | | | | | | | |
| Date | Time | Load | | Dial Gauge Reading | | | | | X | Y | Remarks |
| | | | | Gauge 1 | Gauge 2 | Gauge 3 | Gauge 4 | Average | | | |
| | | (%) | (Ton) | SQC 932 | SQC 925 | SQC 927 | SRE 336 | (mm) | SQC 933 | MLH 224 | |
| | | 0% | 0 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 25.00 | 25.00 | |
| | | | | | | | | | | | |
| | 10:30 | 25% | 58.5 | 0.15 | 0.13 | 0.08 | 0.15 | 0.13 | 25.00 | 25.00 | |
| | 10:40 | | 568 psi | 0.14 | 0.13 | 0.10 | 0.16 | 0.13 | 25.00 | 25.02 | |
| | 10:50 | | | 0.13 | 0.13 | 0.10 | 0.16 | 0.13 | 25.03 | 25.03 | |
| | 11:00 | | | 0.12 | 0.12 | 0.11 | 0.18 | 0.13 | 25.04 | 25.04 | |
| | 11:10 | | | 0.13 | 0.14 | 0.14 | 0.17 | 0.15 | 25.04 | 25.04 | |
| | 11:20 | | | 0.14 | 0.15 | 0.15 | 0.16 | 0.15 | 25.07 | 25.04 | |
| | 11:30 | | | 0.14 | 0.15 | 0.15 | 0.16 | 0.15 | 25.08 | 25.05 | |
| | | | | | | | | | | | |
| | 11:35 | 50% | 117 | 0.58 | 0.57 | 0.60 | 0.59 | 0.59 | 25.15 | 25.16 | |
| | 11:45 | | 1136 psi | 0.60 | 0.57 | 0.60 | 0.58 | 0.59 | 25.15 | 25.16 | |
| | 11:55 | | | 0.63 | 0.60 | 0.62 | 0.60 | 0.61 | 25.15 | 25.16 | |
| | 12:05 | | | 0.65 | 0.63 | 0.62 | 0.61 | 0.63 | 25.15 | 25.16 | |
| | 12:15 | | | 0.68 | 0.65 | 0.62 | 0.62 | 0.64 | 25.15 | 25.16 | |
| | 12:25 | | | 0.70 | 0.66 | 0.63 | 0.62 | 0.65 | 25.15 | 25.16 | |
| | 12:35 | | | 0.70 | 0.66 | 0.63 | 0.62 | 0.65 | 25.15 | 25.16 | |
| | | | | | | | | | | | |
| | 12:40 | 25% | 58.5 | 0.65 | 0.60 | 0.58 | 0.59 | 0.61 | 25.10 | 25.10 | |
| | 12:50 | | 568 psi | 0.60 | 0.53 | 0.54 | 0.55 | 0.56 | 25.10 | 25.10 | |
| | 13:00 | | | 0.58 | 0.50 | 0.51 | 0.52 | 0.53 | 25.10 | 25.10 | |
| | | | | | | | | | | | |
| | 13:05 | 0% | 0 | 0.20 | 0.21 | 0.21 | 0.32 | 0.24 | 25.04 | 25.09 | |
| | 13:15 | | | 0.20 | 0.21 | 0.21 | 0.30 | 0.23 | 25.04 | 25.09 | |
| | 13:25 | | | 0.20 | 0.20 | 0.20 | 0.30 | 0.23 | 25.04 | 25.09 | |
| | 13:35 | | | 0.18 | 0.20 | 0.20 | 0.29 | 0.22 | 25.04 | 25.09 | |
| | 13:45 | | | 0.18 | 0.20 | 0.18 | 0.28 | 0.21 | 25.04 | 25.09 | |
| | 13:55 | | | 0.18 | 0.19 | 0.18 | 0.26 | 0.20 | 25.04 | 25.09 | |
| | 14:05 | | | 0.17 | 0.16 | 0.17 | 0.25 | 0.19 | 25.04 | 25.09 | |
| | | | | | | | | | | | |

**Uji Beban**
**Statik Aksial Tekan**

# Hasil Pembacaan Load Cell

**VIBRATING WIRE LOAD CELL RECORDING FORM**

1~6 %

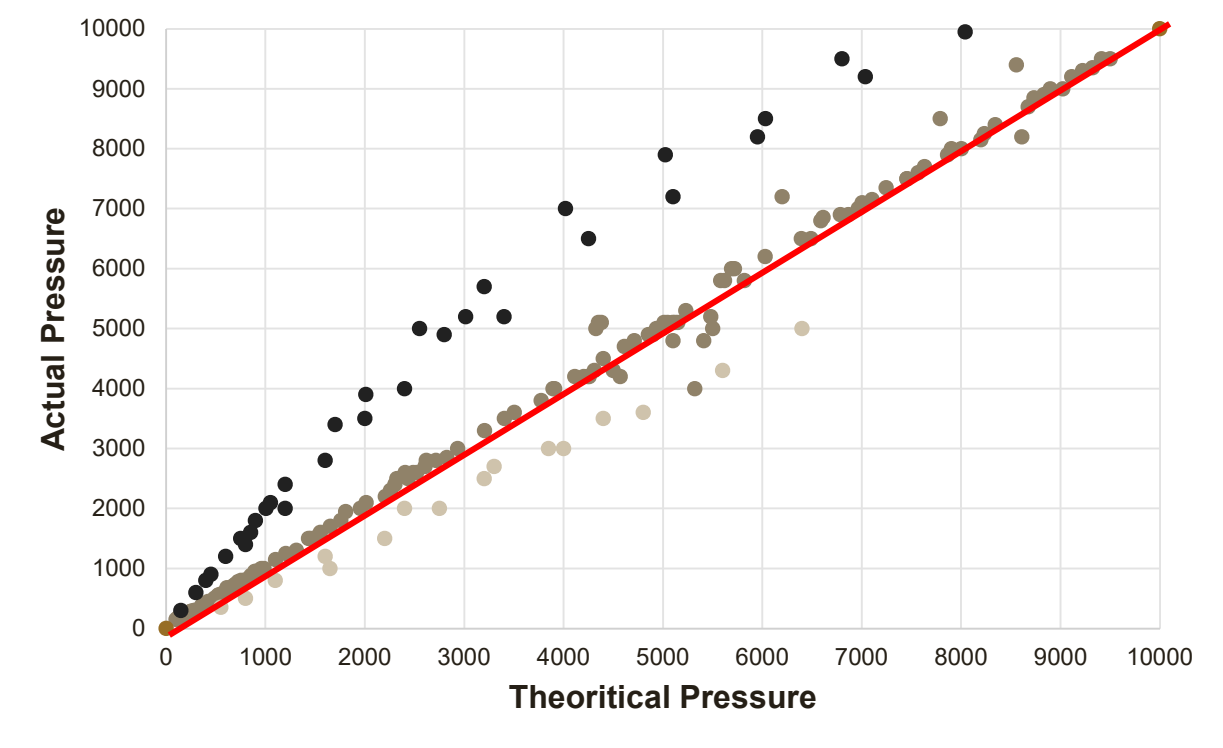
| PROJECT | | | | | | | LOAD CELL | | SHEET NO |
|---|---|---|---|---|---|---|---|---|---|
| LOCATION | | | PILE NO. | | | | 1214460 | | |
| PILE DIA (MM) | 1200 | | PILE TEST DATE | | | GES FACTOR | 0.4012 | | |
| WORKING LOAD (TON) | 234 | | MAX. TEST LOAD (TON) | 468 | | ZERO READING | 7200 | | |

| % LOAD | DATE | TIME | THEORETICAL LOAD | | VIBRATING WIRE LOAD CELL READING (Dg) | | | | | ACTUAL LOAD | | DIFF | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | (TON) | (PSI) | 1 | 2 | 3 | 4 | Rata-rata | (TON) | (PSI) | (%) | |
| 0% | | 23:55 | 0 | 0 | 7118 | 7296 | 7267 | 7119 | 7200 | 0 | 0 | 0 | |
| 50% | | 0:00 | 117 | 1136 | 6926 | 7075 | 6916 | 6694 | 6903 | 119 | 1200 | 6 | |
| 100% | | 0:25 | 234 | 2273 | 6719 | 6738 | 6656 | 6318 | 6608 | 238 | 2300 | 1 | |
| 150% | | 0:50 | 351 | 3409 | 6472 | 6536 | 6352 | 5907 | 6317 | 354 | 3500 | 3 | |
| 175% | | 1:15 | 409.5 | 3977 | 6281 | 6447 | 6211 | 5743 | 6171 | 413 | 4000 | 1 | |
| 200% | | 2:20 | 468 | 4545 | 6186 | 6298 | 6129 | 5428 | 6010 | 477 | 4700 | 3 | |
| 200% | | 4:20 | 468 | 4545 | 6193 | 6305 | 6132 | 5437 | 6017 | 475 | 4700 | 3 | |
| 150% | | 14:25 | 351 | 3409 | 6419 | 6548 | 6361 | 5892 | 6305 | 359 | 3600 | 6 | |
| 100% | | 15:30 | 234 | 2273 | 6698 | 6769 | 6678 | 6284 | 6607 | 238 | 2400 | 6 | |
| 50% | | 16:35 | 117 | 1136 | 6874 | 6995 | 6958 | 6728 | 6889 | 125 | 1200 | 6 | |
| 0% | | 17:40 | 0 | 0 | 7119 | 7299 | 7268 | 7120 | 7202 | 0 | 0 | 0 | |

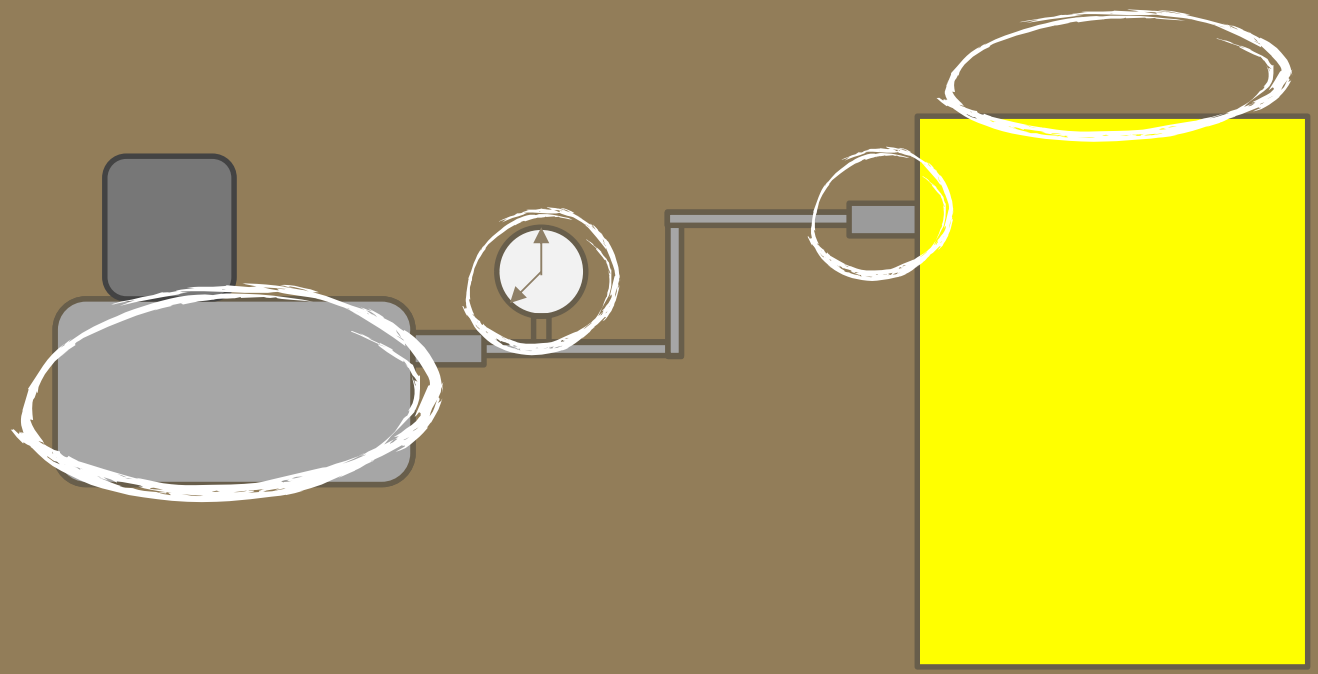
# Apa sih LOAD CELL?

# Kenapa LOAD CELL penting?

# Teori vs Aktual
# Harapan vs Kenyataan

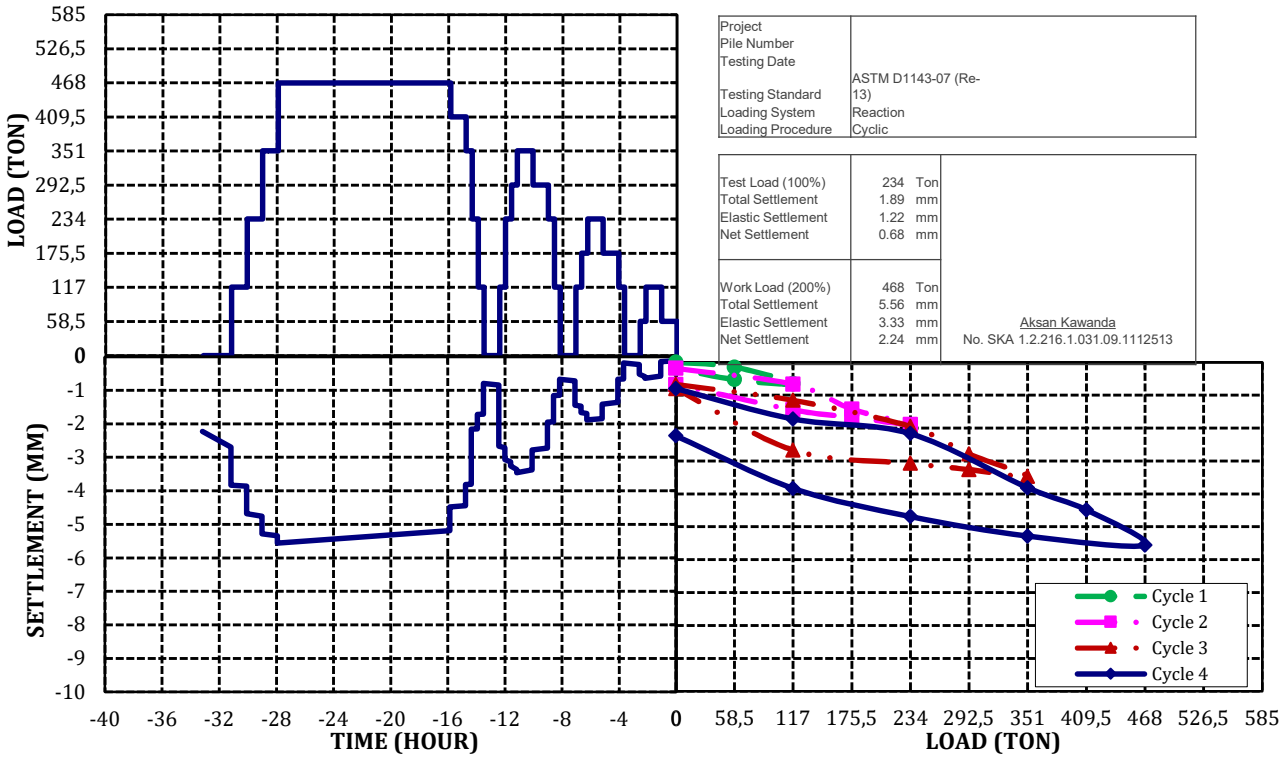


# SISTEM POMPA HIDROLIK



## Uji Beban Statik Aksial Tekan

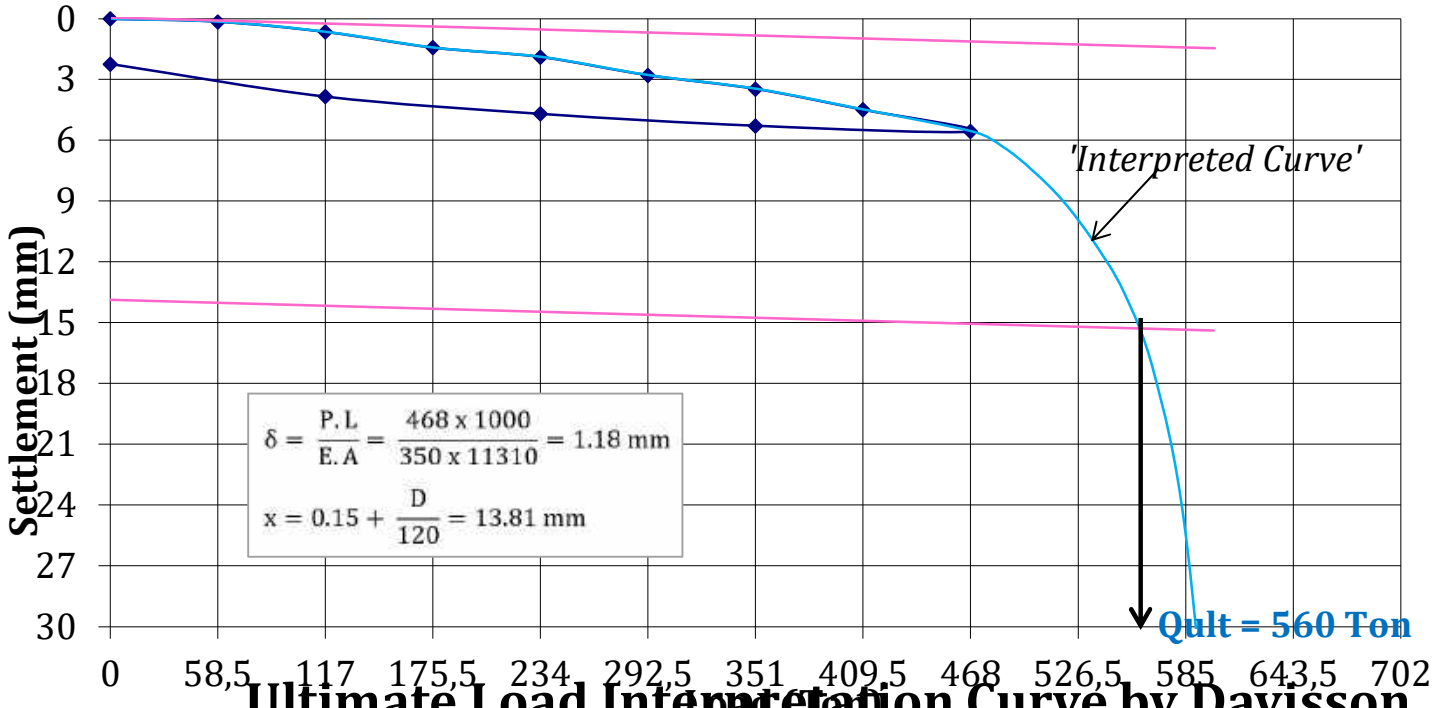
# Hasil Uji




KURVA BEBAN – WAKTU – PENURUNAN

Uji Beban
Statik Aksial Tekan

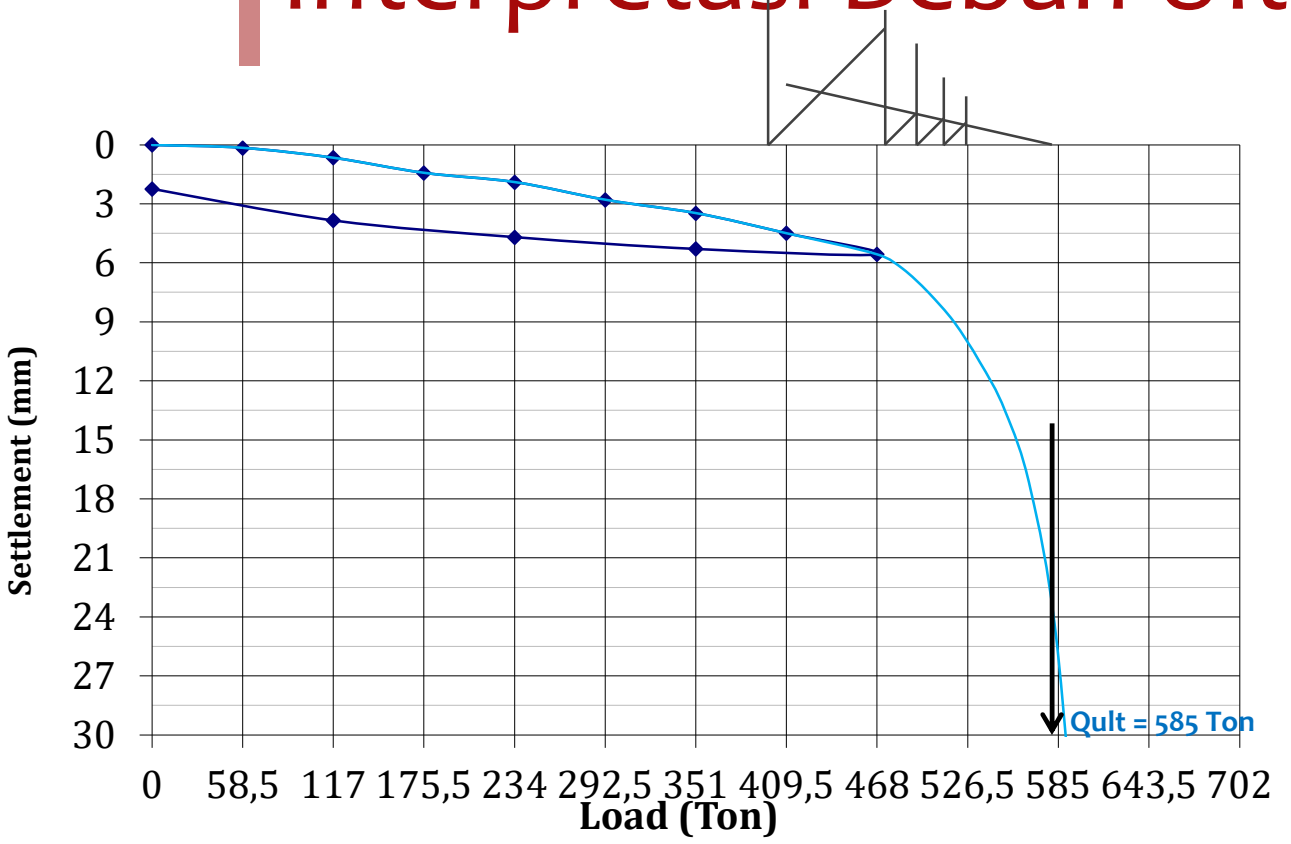
# Interpretasi Beban Ultimit




**Ultimate Load Interpretation Curve by Davisson Method**

**Uji Beban**
**Statik Aksial Tekan**

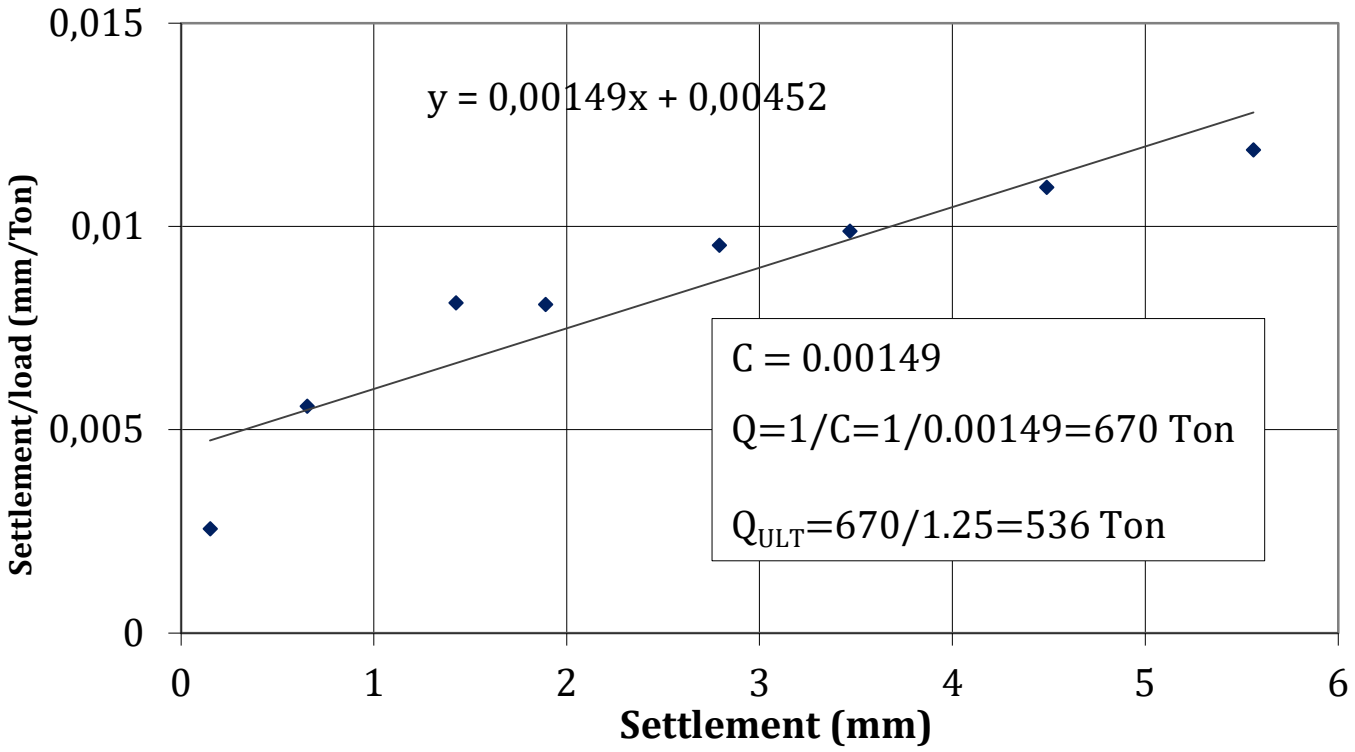
# Interpretasi Beban Ultimit




**Ultimate Load Interpretation Curve by Mazurkiewich Method**

Uji Beban
Statik Aksial Tekan

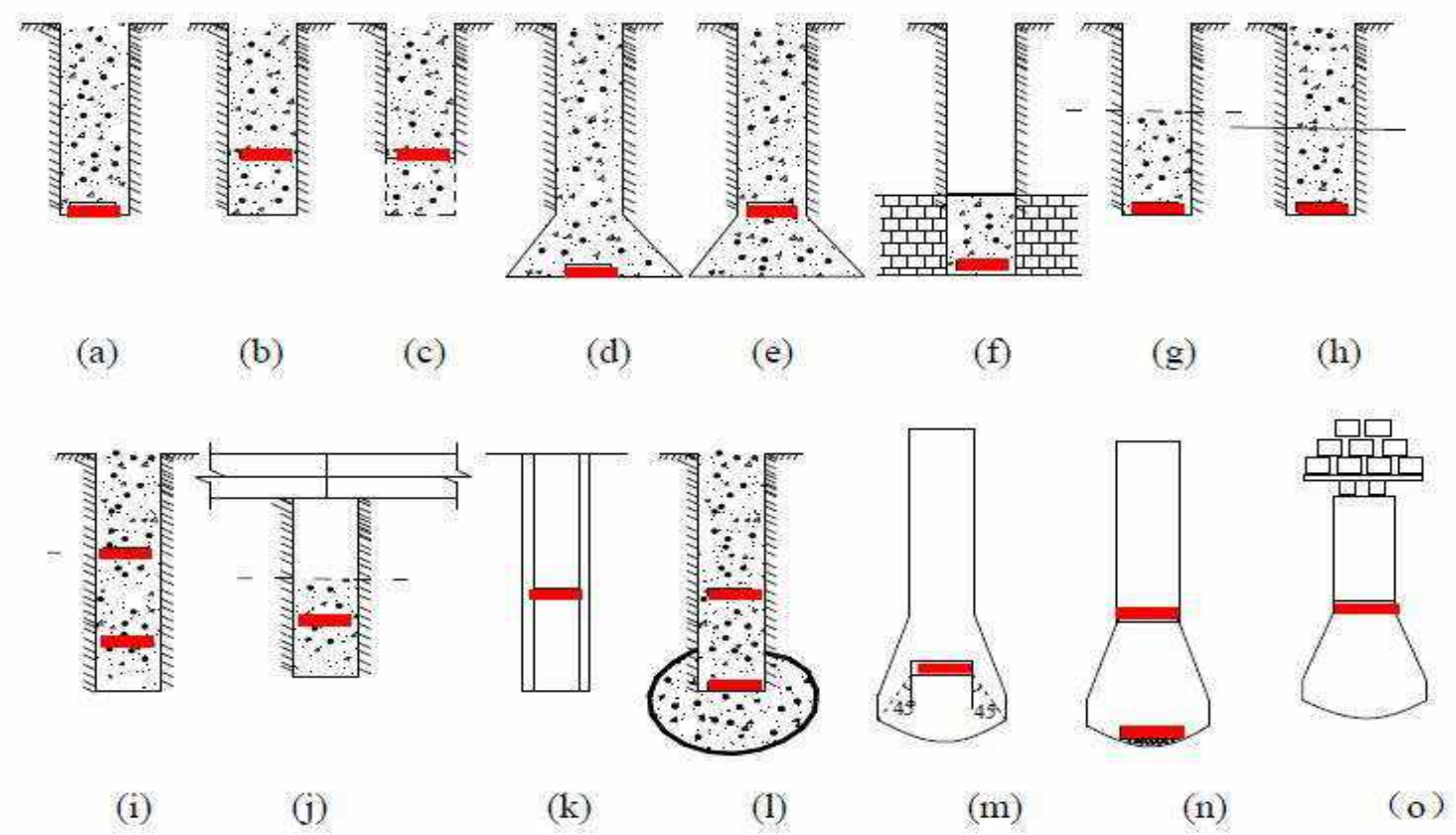
# Interpretasi Beban Ultimit




**Ultimate Load Interpretation Curve by Chin Method**

# *Metode Pembebanan Cell 2-arah*

# Posisi tipikal cell 2-arah:



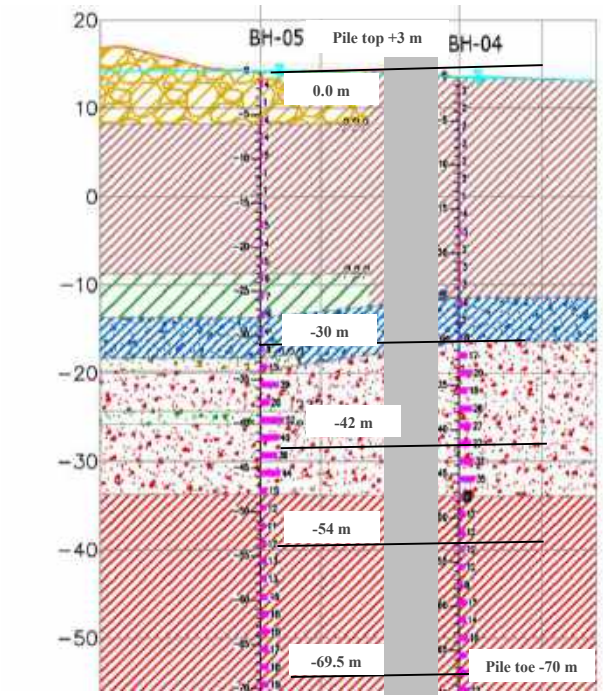
# Cell 2-arah (Geo-Cell):

# Pemasangan cell ke Tulangan

# Memasukkan tulangan dan Cell ke lubang bor

# Proses Pengujian

# Instumentasi dan *setting-up*




Vibrating Wire Strain Gauge Elevation

Load Test Arrangement

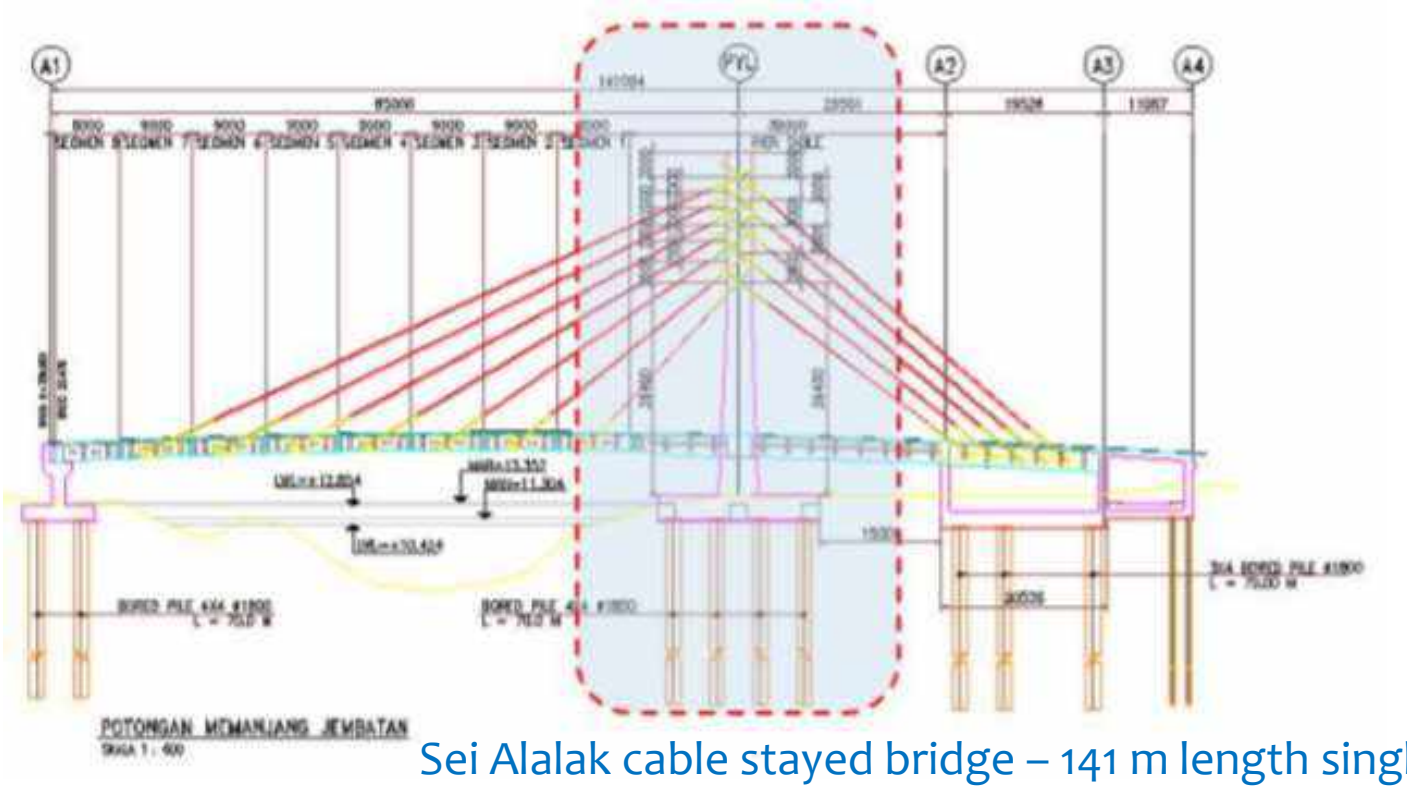

## Sei Alalak Cable Stayed Bridge:

Sei Alalak cable stayed bridge –
141 m length single curved span

Bored pile

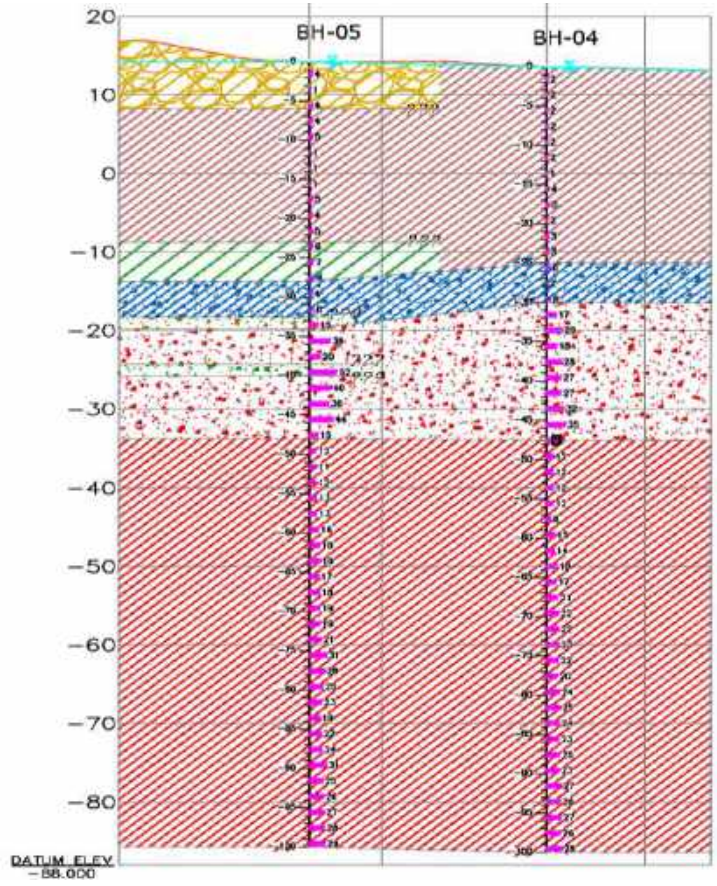
1.8 m diameter and 70 m depth
Ultimate load 1560 tons

# CASE: Sei Alalak Cable Stayed Bridge:




Sei Alalak cable stayed bridge – 141 m length single span.
Bored pile with 1.8 m diameter and 70 m depth.
Ultimate load 1560 tons

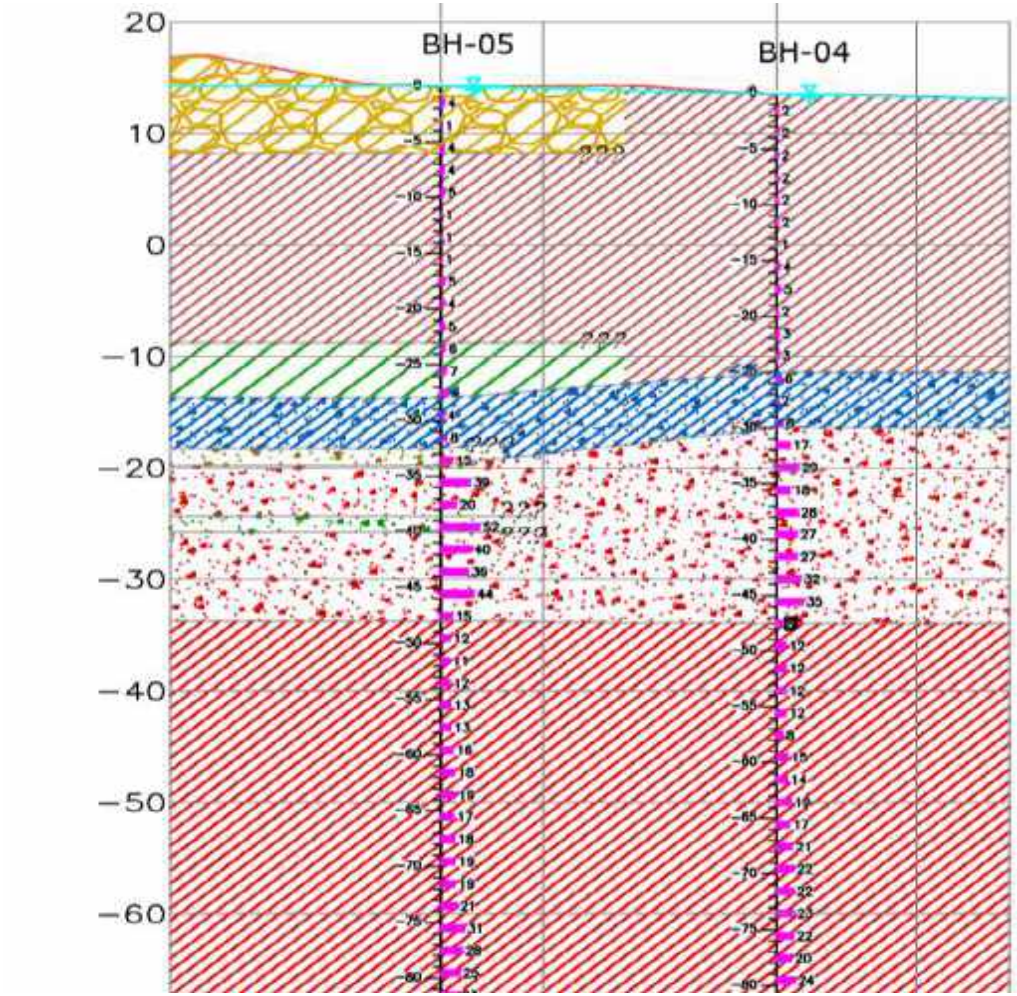
# Sei Alalak Cable Stayed Bridge:

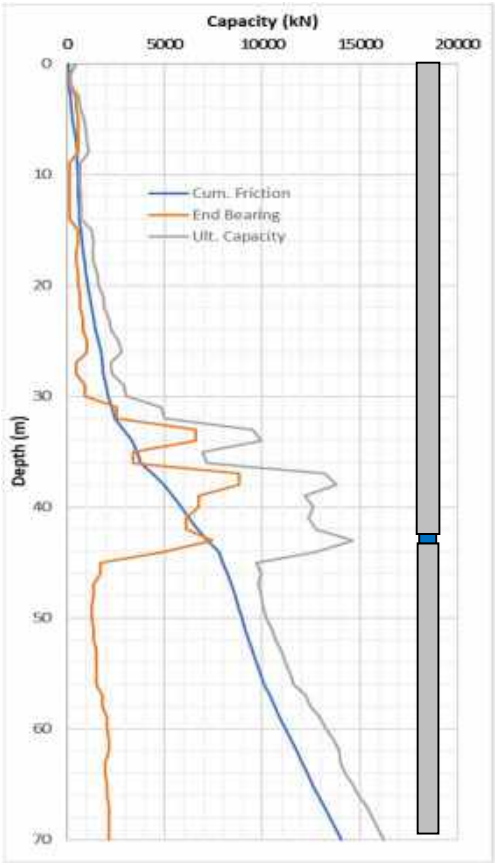




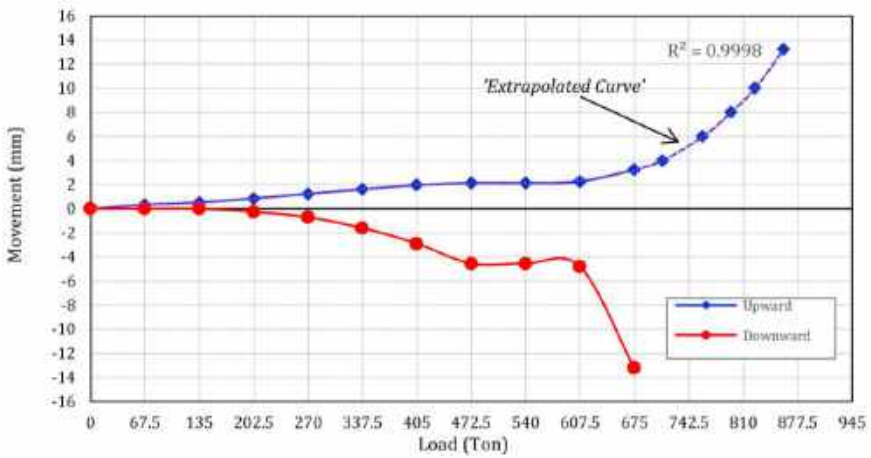
Soil Investigation Record @ Pylon

## Sei Alalak Cable Stayed Bridge:

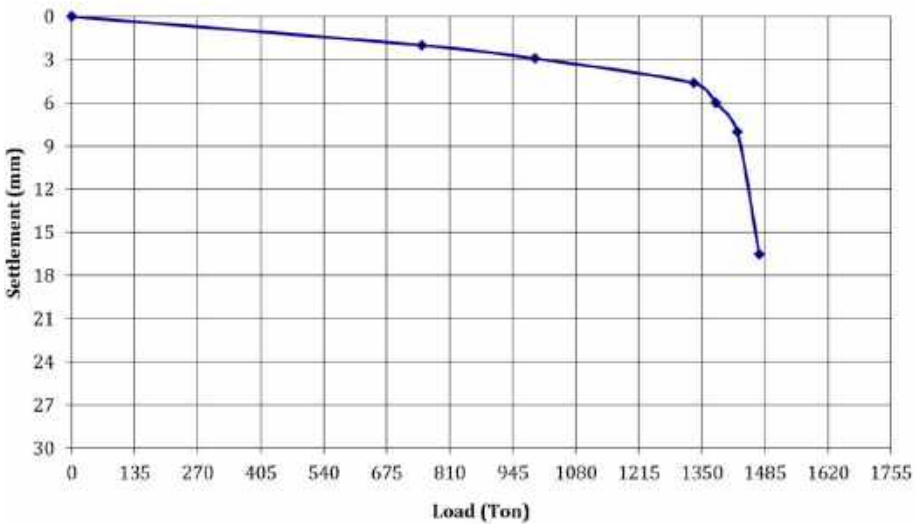


# Sei Alalak Cable Stayed Bridge:




**Downward and Upward Movement**




**Equivalent Top Load - Settlement**

## Static Axial Tension Load Test

# Test Preparation

1. Expose pile head
2. Install footing load
3. Install hydraulic jack, VWLC & Main Beam
4. Install rebar tension
5. Install reference beam and dial gauge.

- Excav… …le group to the fi…
- Remo…
- Expos… …out 80 cm.
- Instal… …t pile about 1 m, t…
- Prepa… … make sure that t… …provement may …
- Instal… …ad cell, dial gages…
- Apply… …asured the settle… …ntrolled by press…
- In or… … on top of every…
- All of… …contractors and check before pile test begin.

**Static Horizontal Load Test**

# Test Preparation

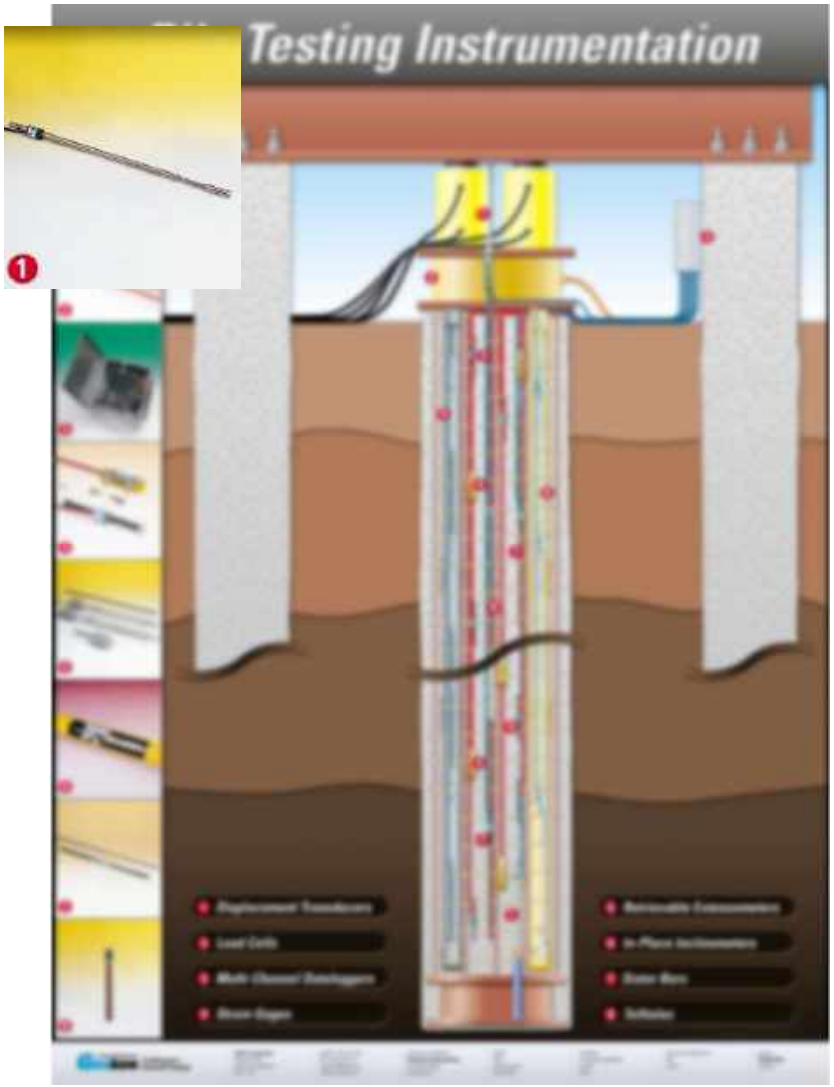
1. Expose test pile
2. Install equipment

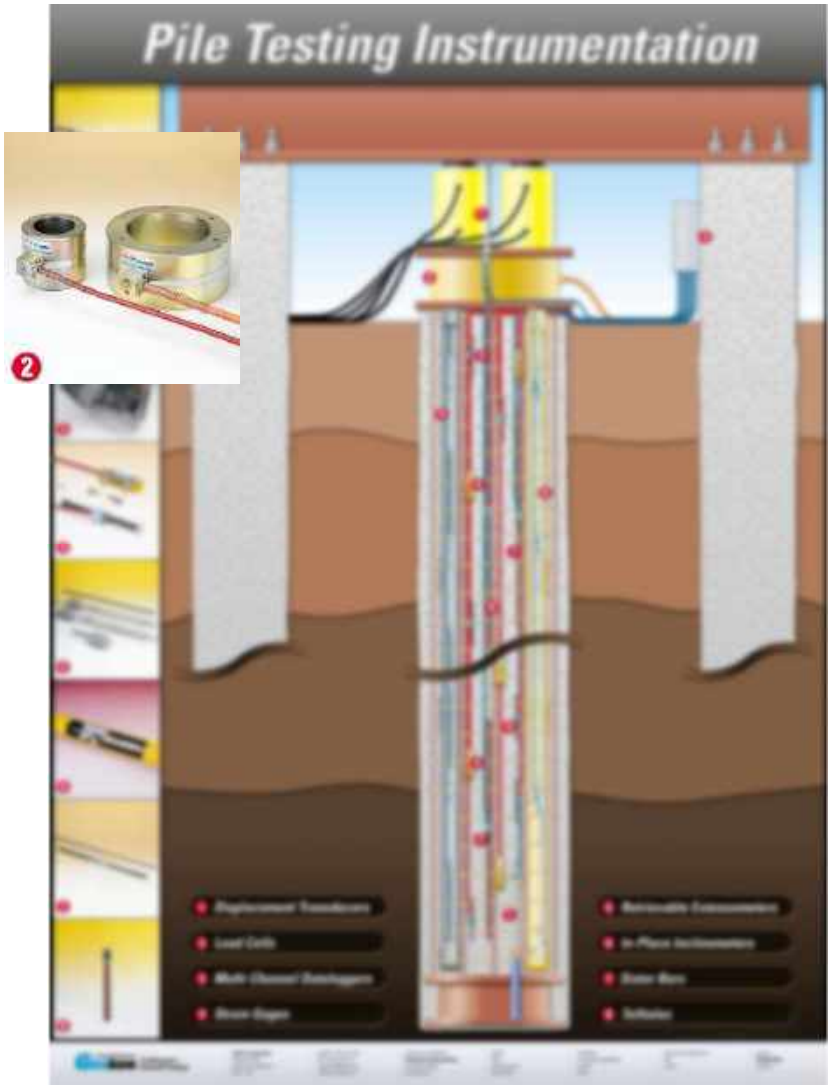
as

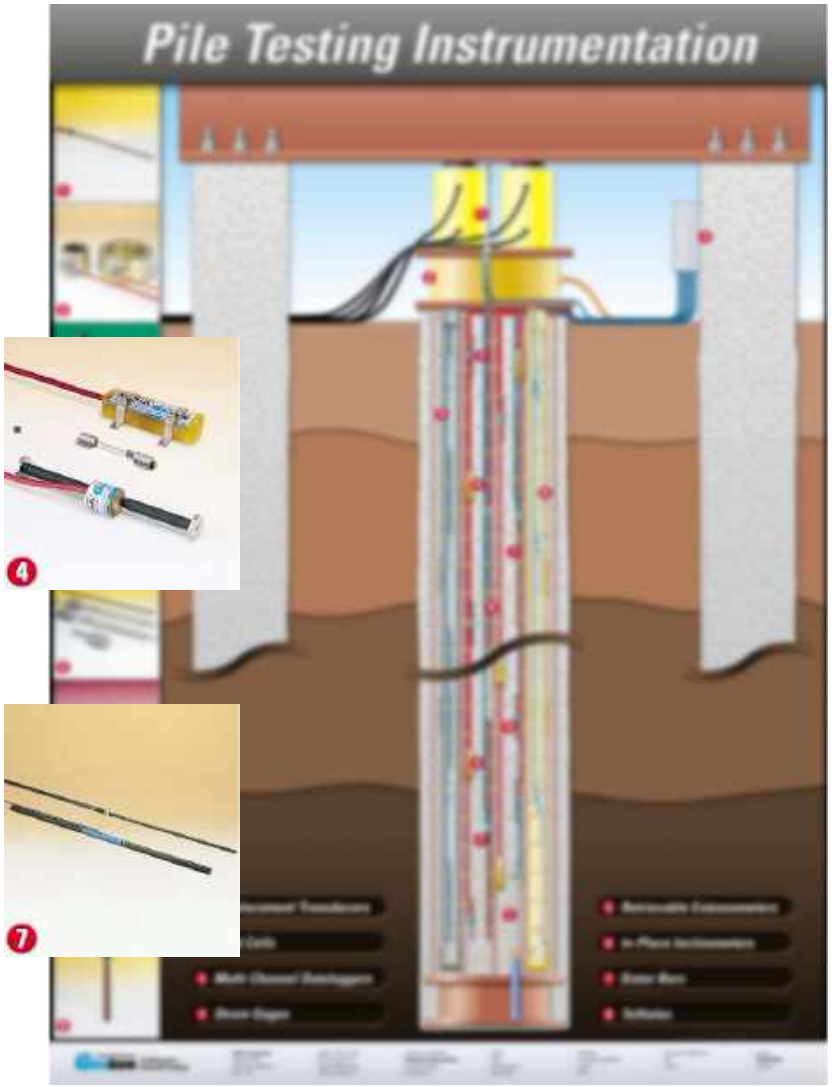
the

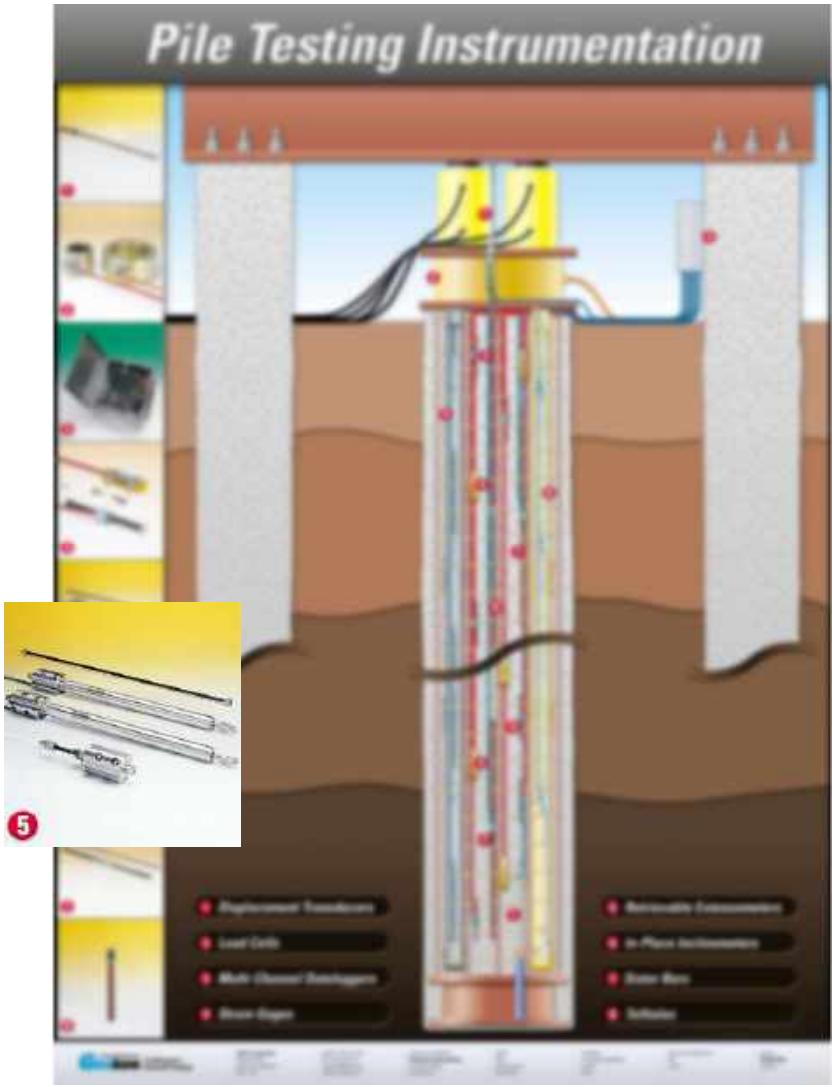
ates

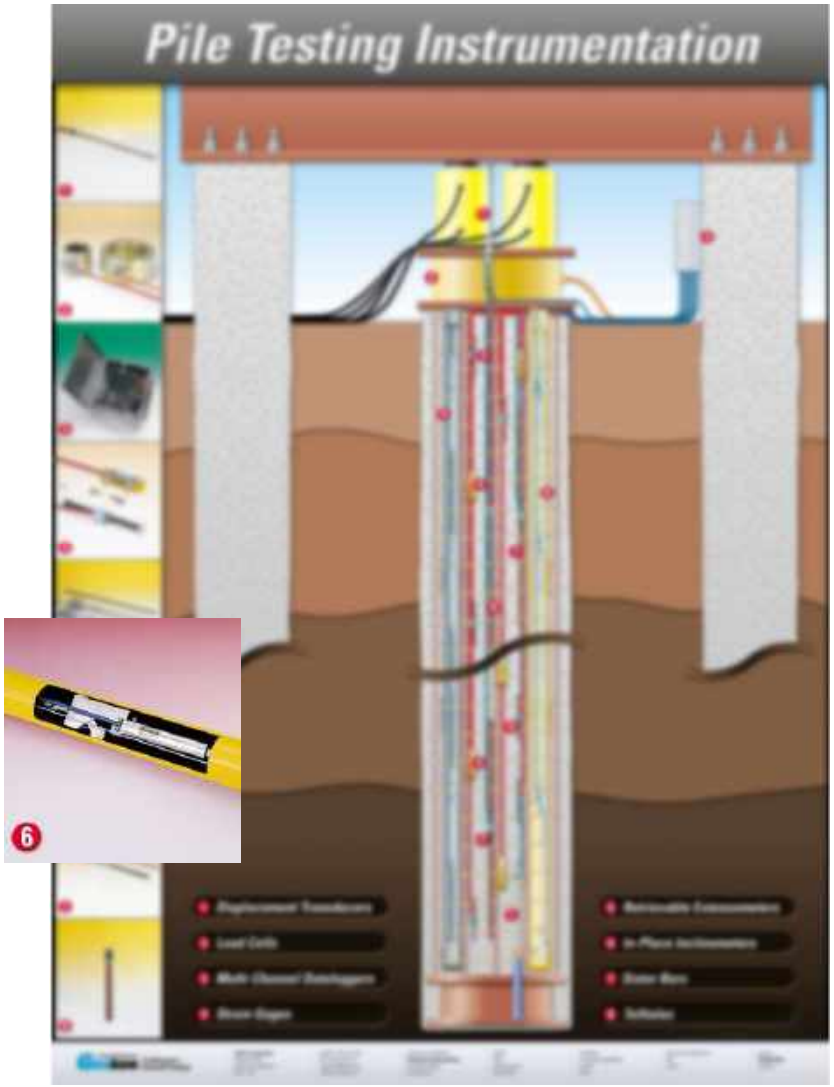
# INSTRUMENTATION

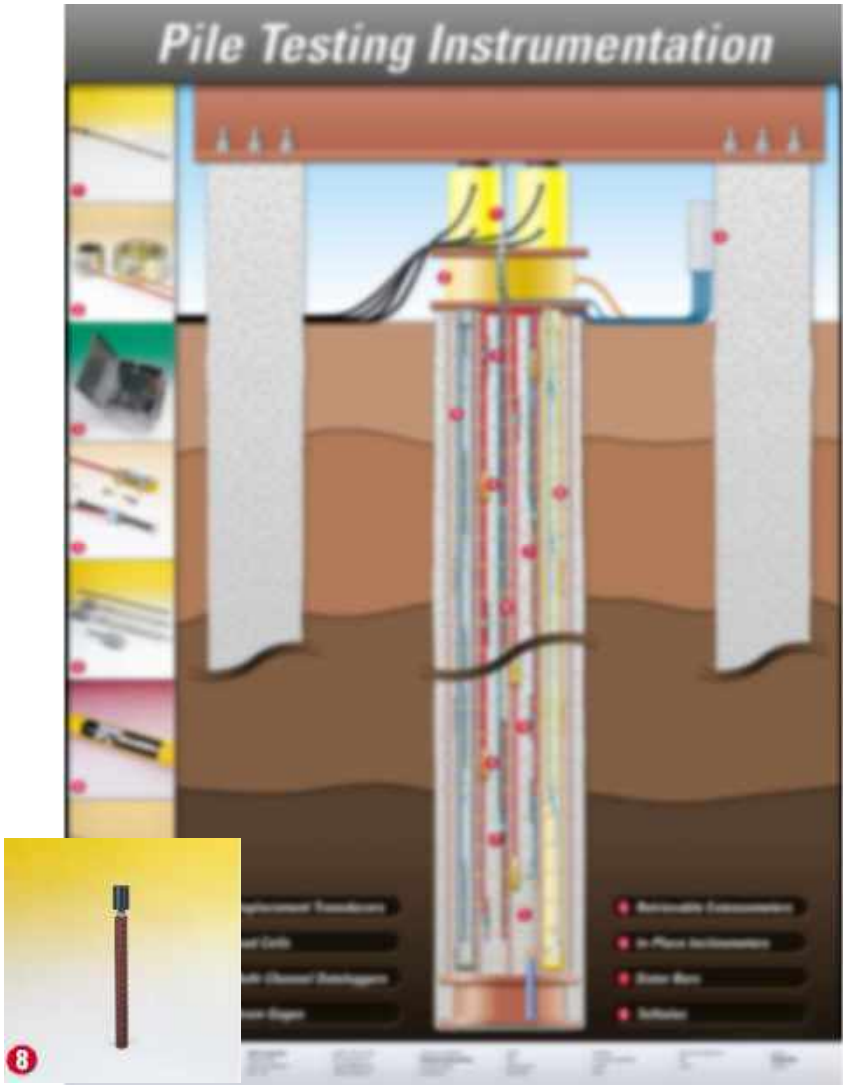

Testing Instrumentation
1


Pile Testing Instrumentation


Pile Testing Instrumentation
4
7

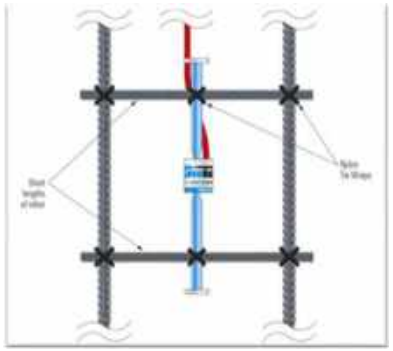

Pile Testing Instrumentation
5

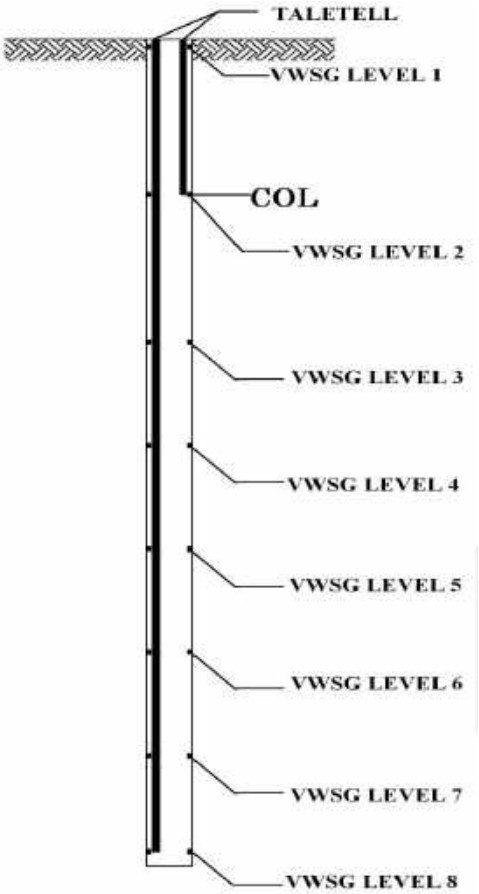

Pile Testing Instrumentation
6


Pile Testing Instrumentation
8

**Uji Beban Statik**

# INSTRUMENTATION





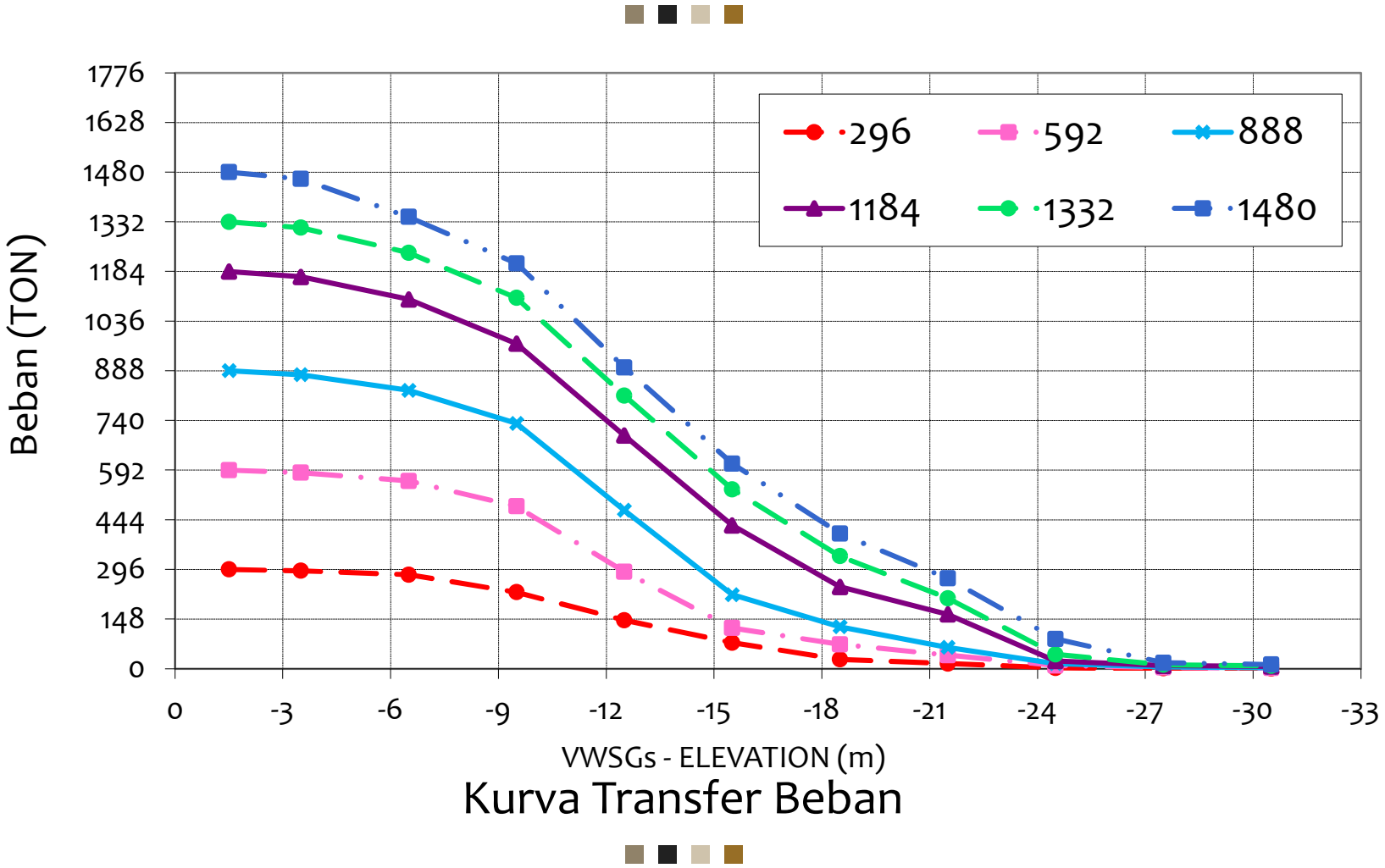

## VWSG

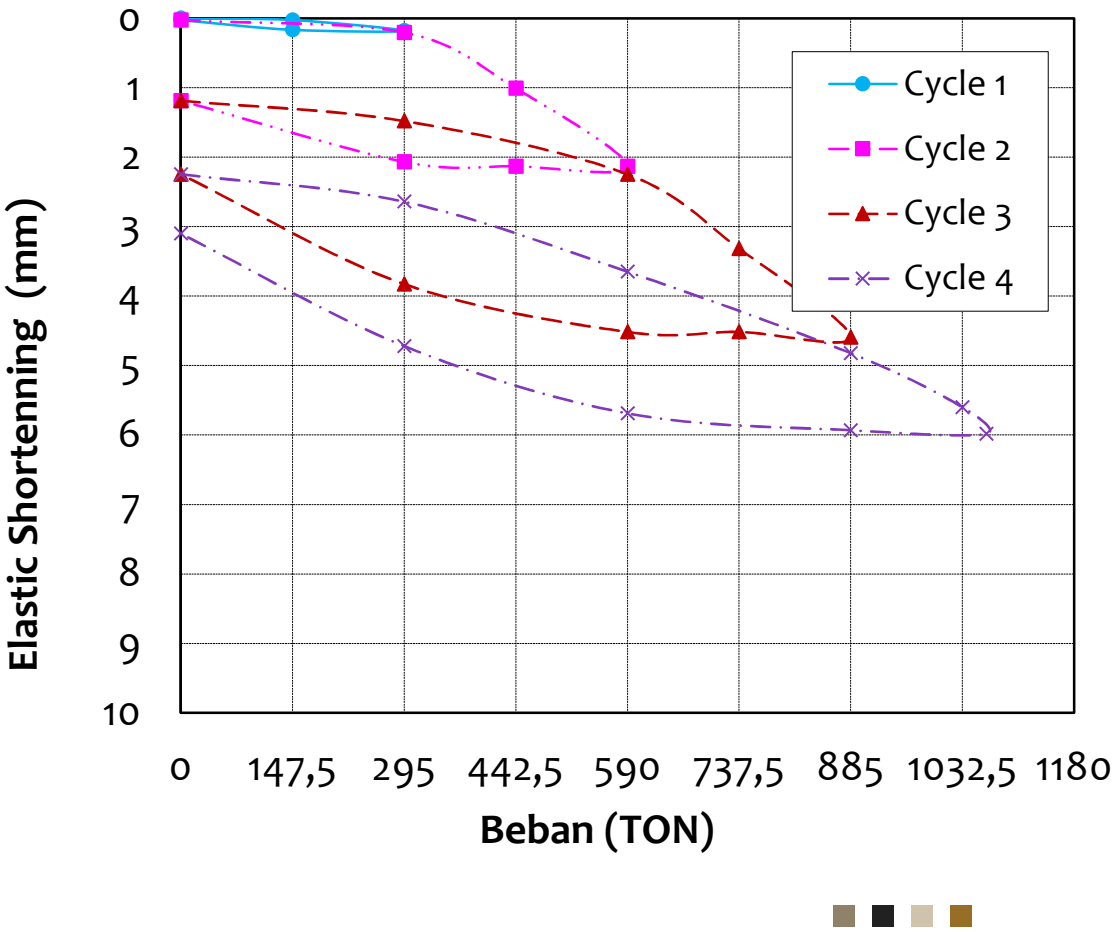
Mengukur transfer beban pada masing-masing elevasi;

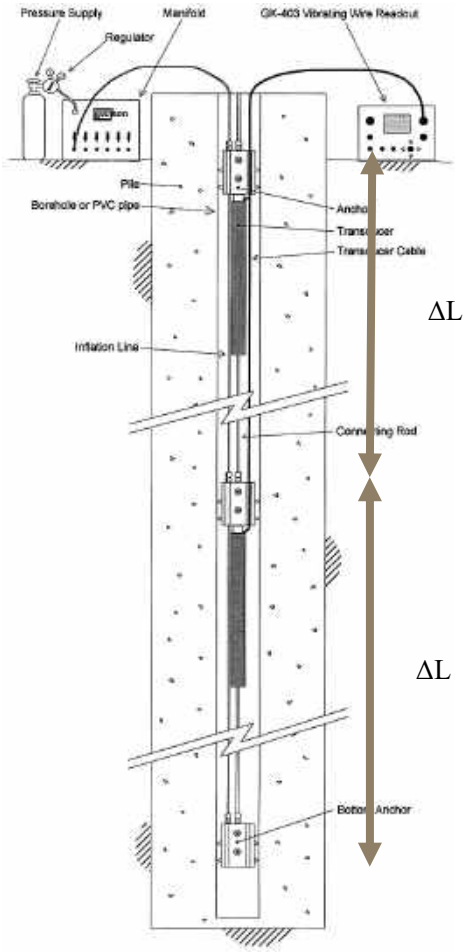
Mengukur mobilisasi tahanan selimut dan tahanan ujung;

## TALE-TELL EXTENSOMETER

Mengukur penurunan pada lokasi COL dan ujung dasar tiang


Beban (TON)
1776
1628
1480
1332
1184
1036
888
740
592
444
296
148
0
296
592
888
1184
1332
1480
0
-3
-6
-9
-12
-15
-18
-21
-24
-27
-30
-33
VWSGs - ELEVATION (m)
Kurva Transfer Beban




GEOTECH EFATHAMA

# INSTALLATION

**WAJIB DILAKUKAN DI POSISI COL ATAU LAKUKAN TINDAKAN KHUSUS**

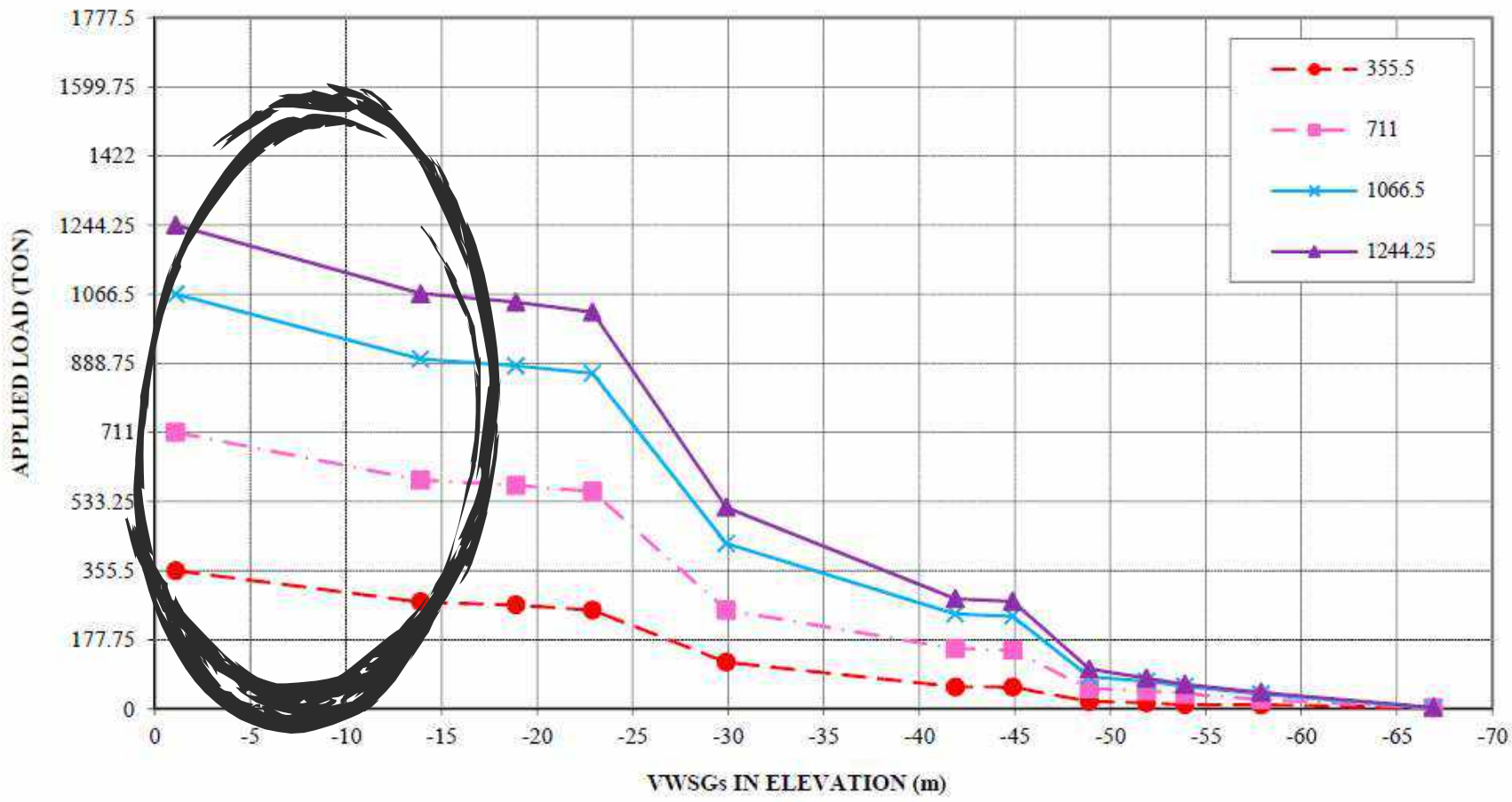
# AND FRICTION CORRECTION

Penggunaan Instrumentasi

$$\varepsilon = P/EA$$

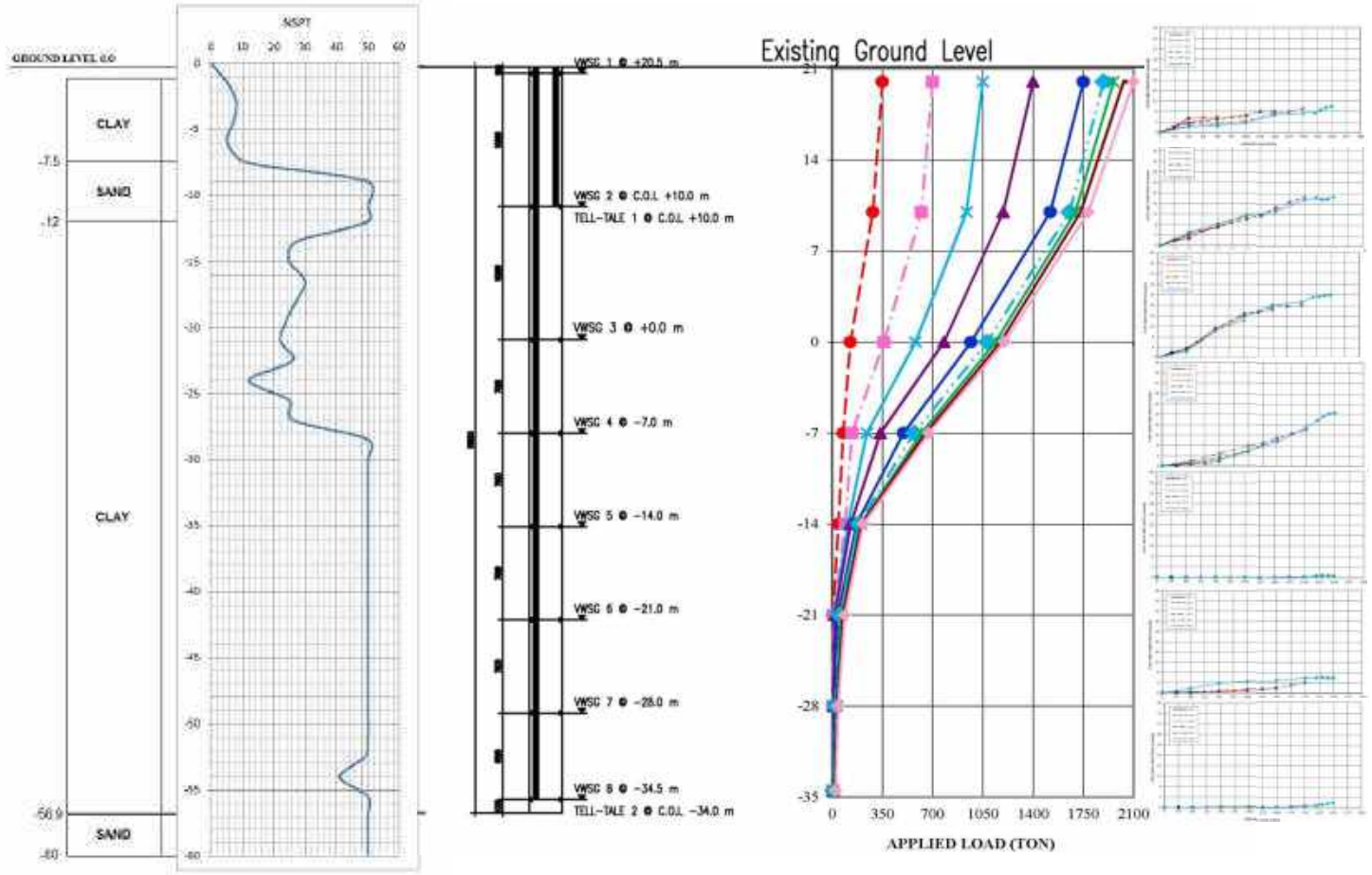
ε = Strain
P = Load
E = Elastic modulus
A = Area


# KENAPA WAJIB DILAKUKAN DI POSISI C.O.L

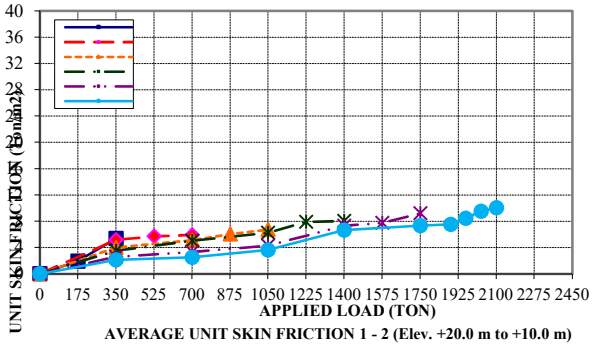



APPLIED LOAD (TON)
887.5
798.75
710
621.25
532.5
443.75
355
266.25
177.5
88.75
0
178
355
533
621
45
-50

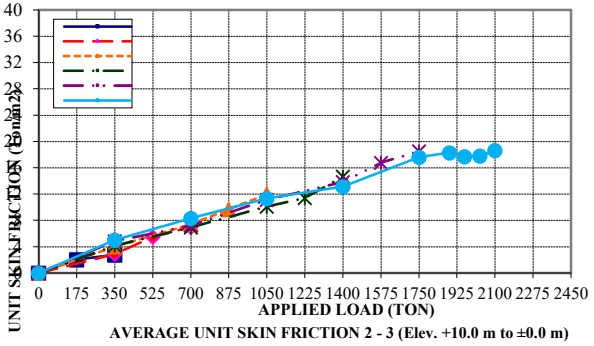
# HASIL ANALISA VWSG



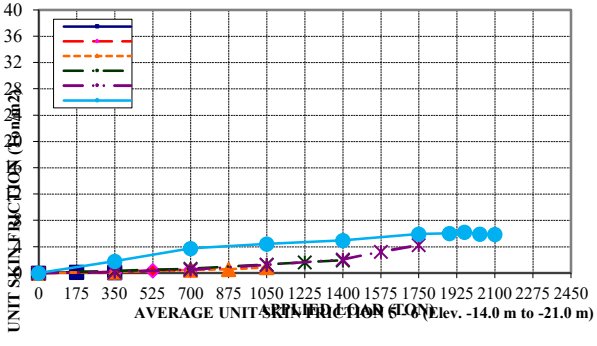
# GRAFIK TAHANAN SELIMUT



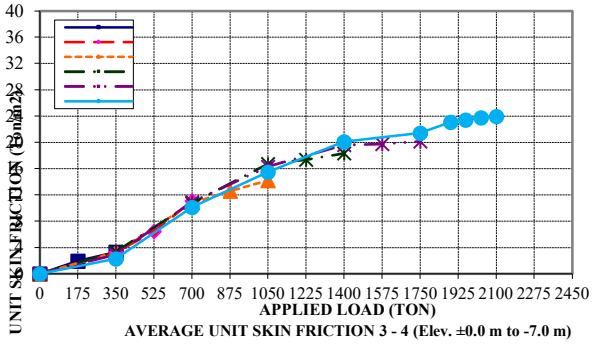
AVERAGE UNIT SKIN FRICTION 1 - 2 (Elev. +20.0 m to +10.0 m)



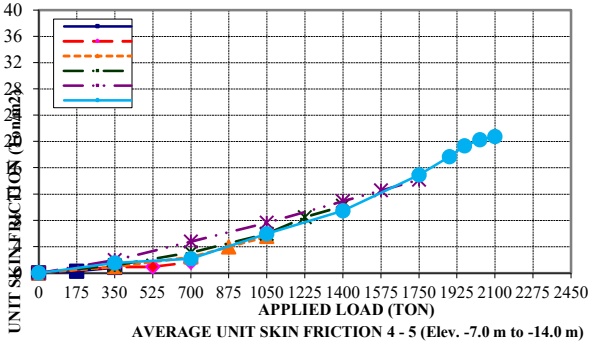
AVERAGE UNIT SKIN FRICTION 2 - 3 (Elev. +10.0 m to ±0.0 m)



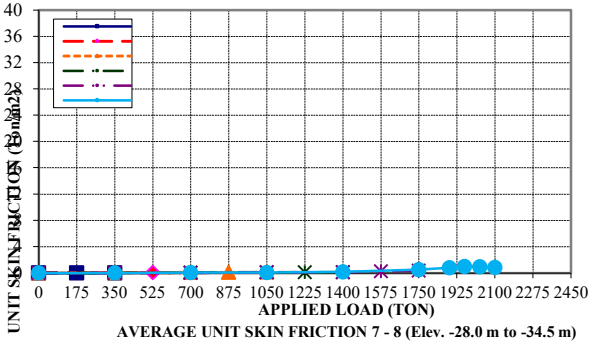
AVERAGE UNIT SKIN FRICTION 6 - 7 (Elev. -14.0 m to -21.0 m)



AVERAGE UNIT SKIN FRICTION 3 - 4 (Elev. ±0.0 m to -7.0 m)

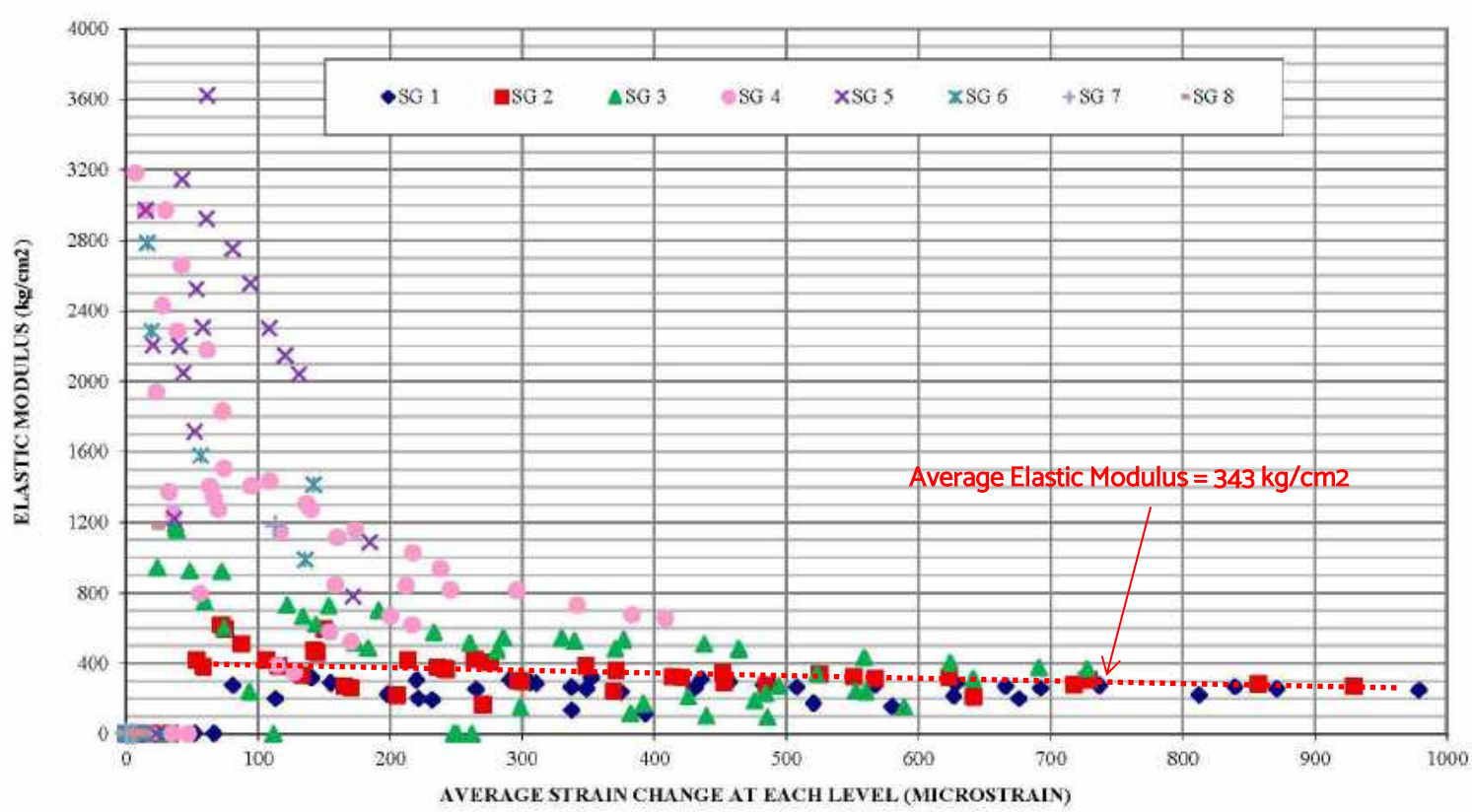


AVERAGE UNIT SKIN FRICTION 4 - 5 (Elev. -7.0 m to -14.0 m)



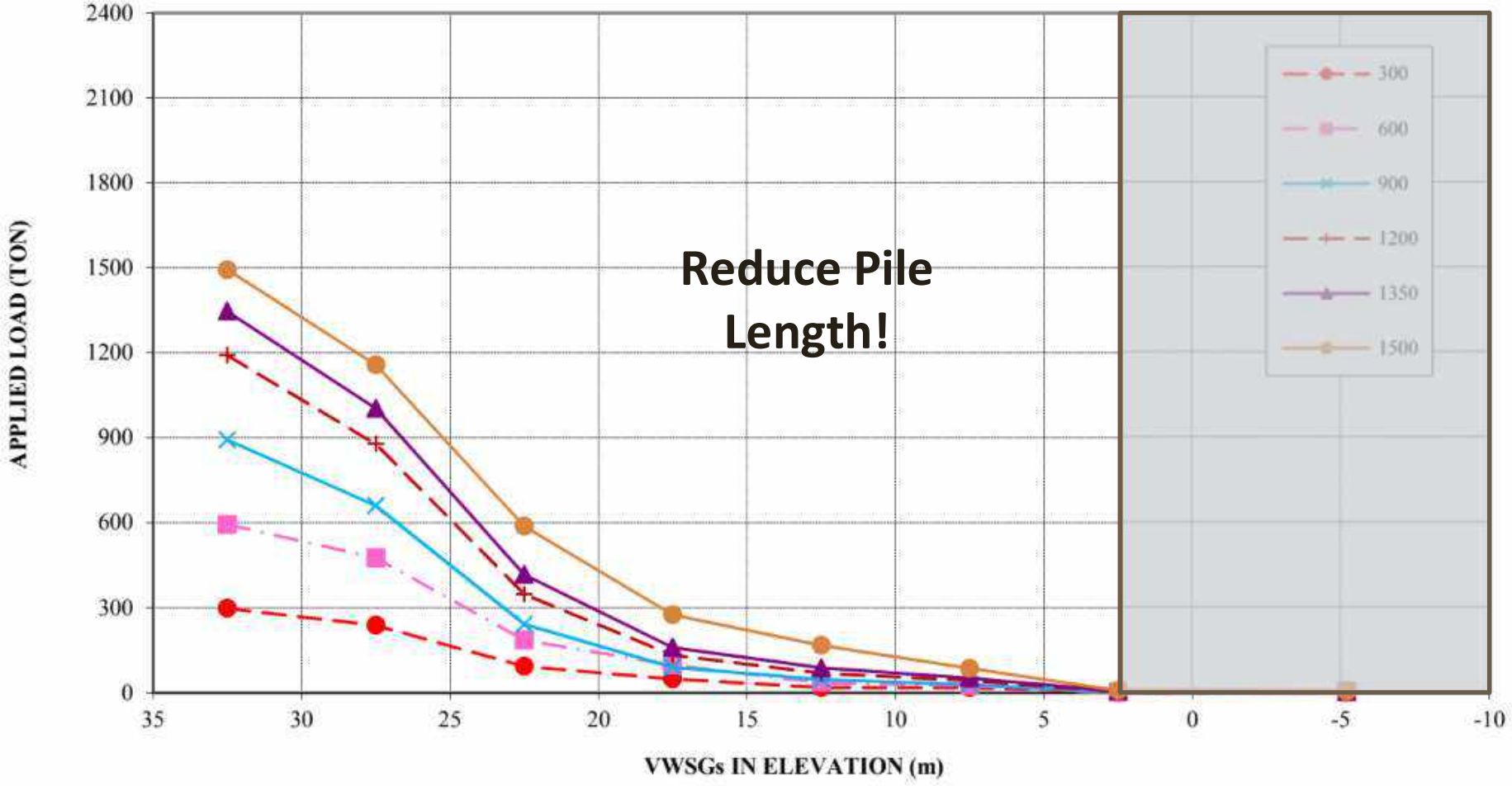
AVERAGE UNIT SKIN FRICTION 7 - 8 (Elev. -28.0 m to -34.5 m)

# MENENTUKAN BESARNYA MODULUS ELASTISITAS TIANG UJI




ELASTIC MODULUS VS AVERAGE STRAIN CHANGE

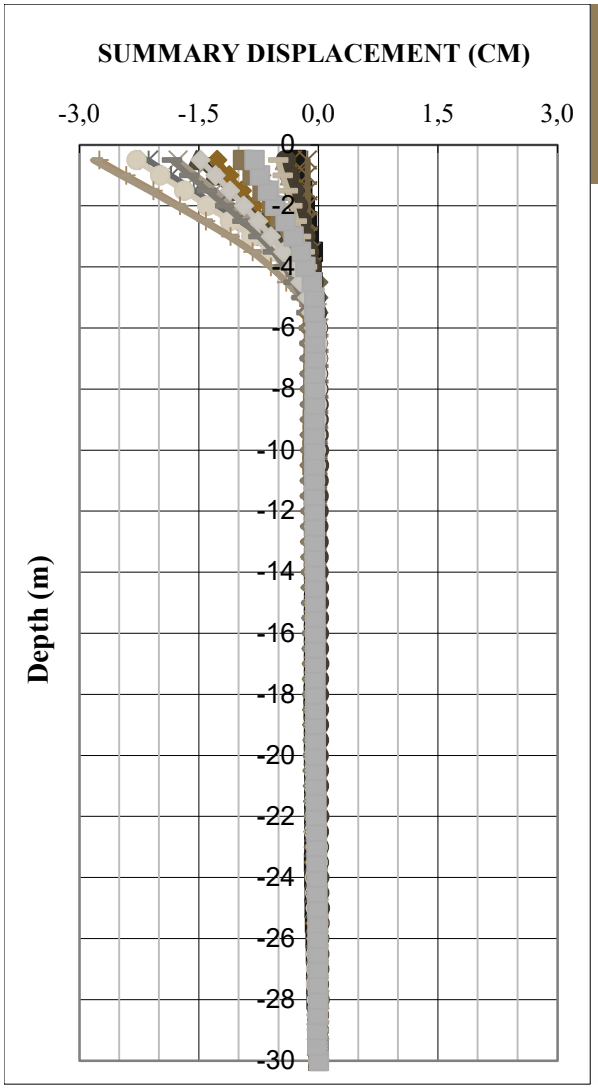
# ANOTHER ADVANTAGES

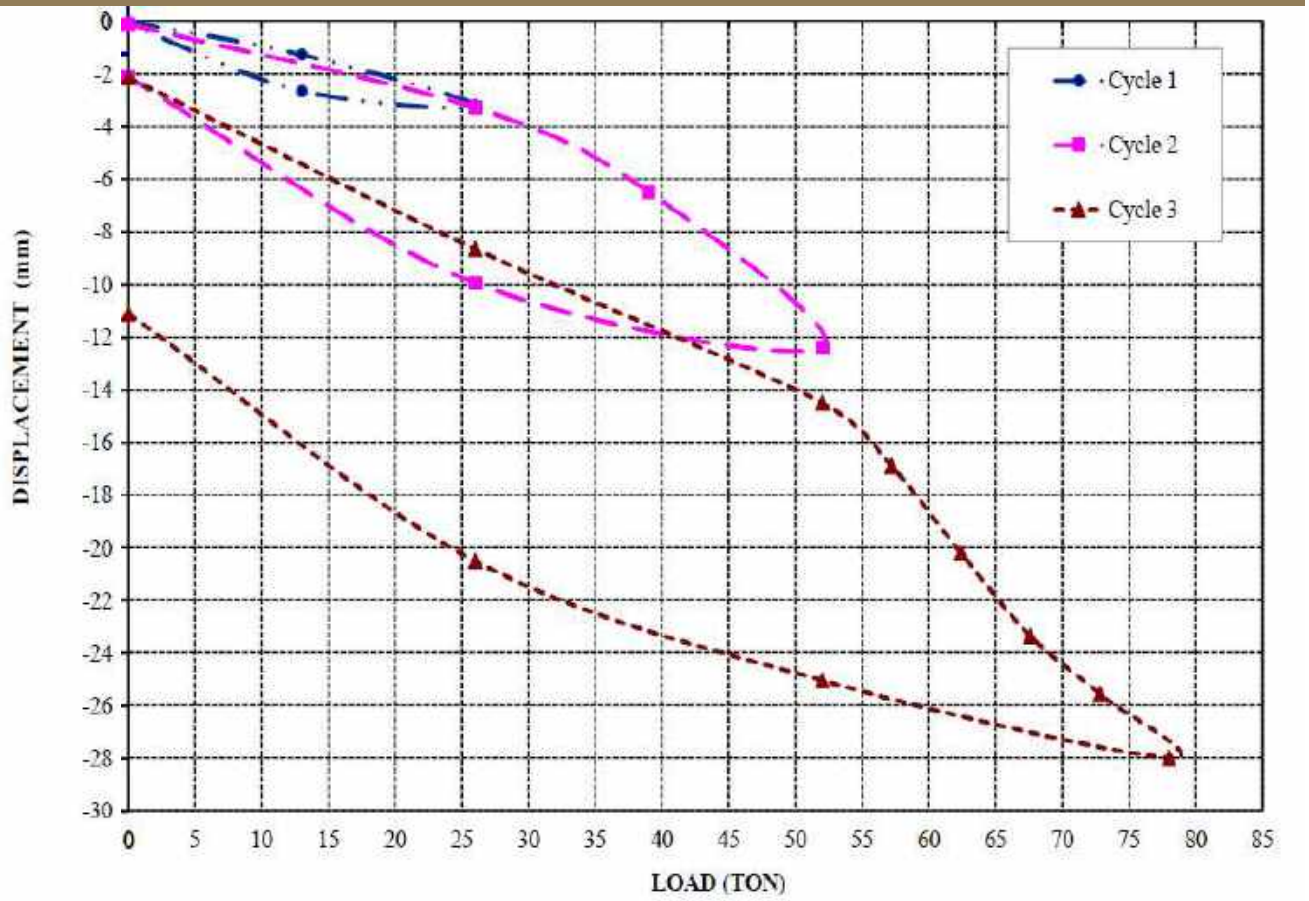


# OTHER INSTRUMENTATION?

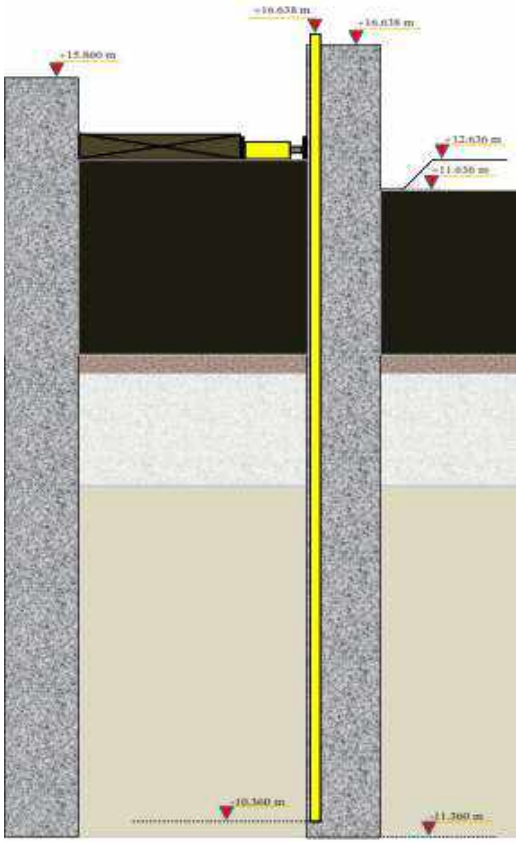
Inclinometer on Lateral Test

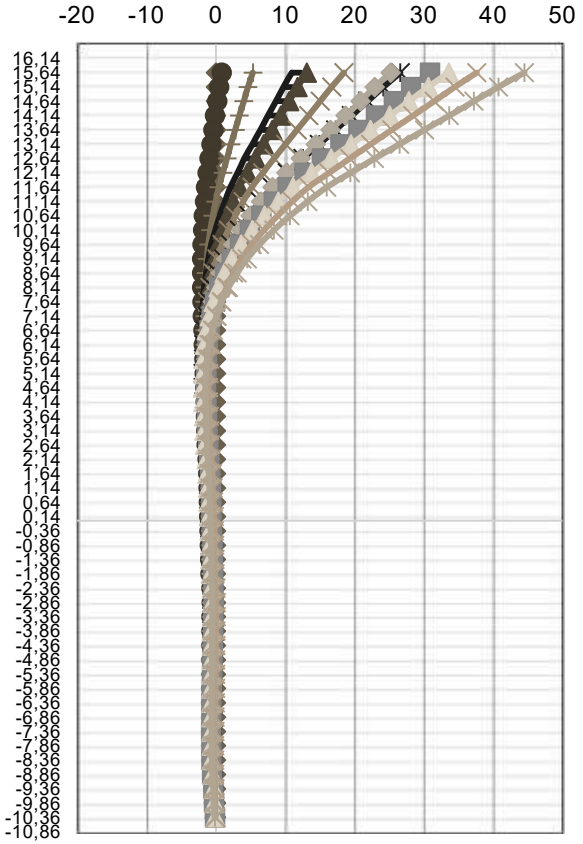
# INCLINOMETER ON LATERAL TEST



# Instrumented Lateral Load





# BEBERAPA HAL YANG PERLU DIPERHATIKAN:

- Pemahaman mengenai standar berlaku.

- Penguji **tersertifikasi**, penggunaan peralatan **berkualitas** dan **terstandar** membuat pengujian tiang yang benar bukan menjadi sarana uji coba.

- Uji statik aksial tekan masih merupakan metode terbaik dari segi kualitas disamping waktu dan biaya. Metode dinamik disarankan untuk dilakukan pengembangan dan dilaksanakan lebih tepat agar dapat menjadi alternatif terhadap uji statik.


# WHEN THING GOES WRONG

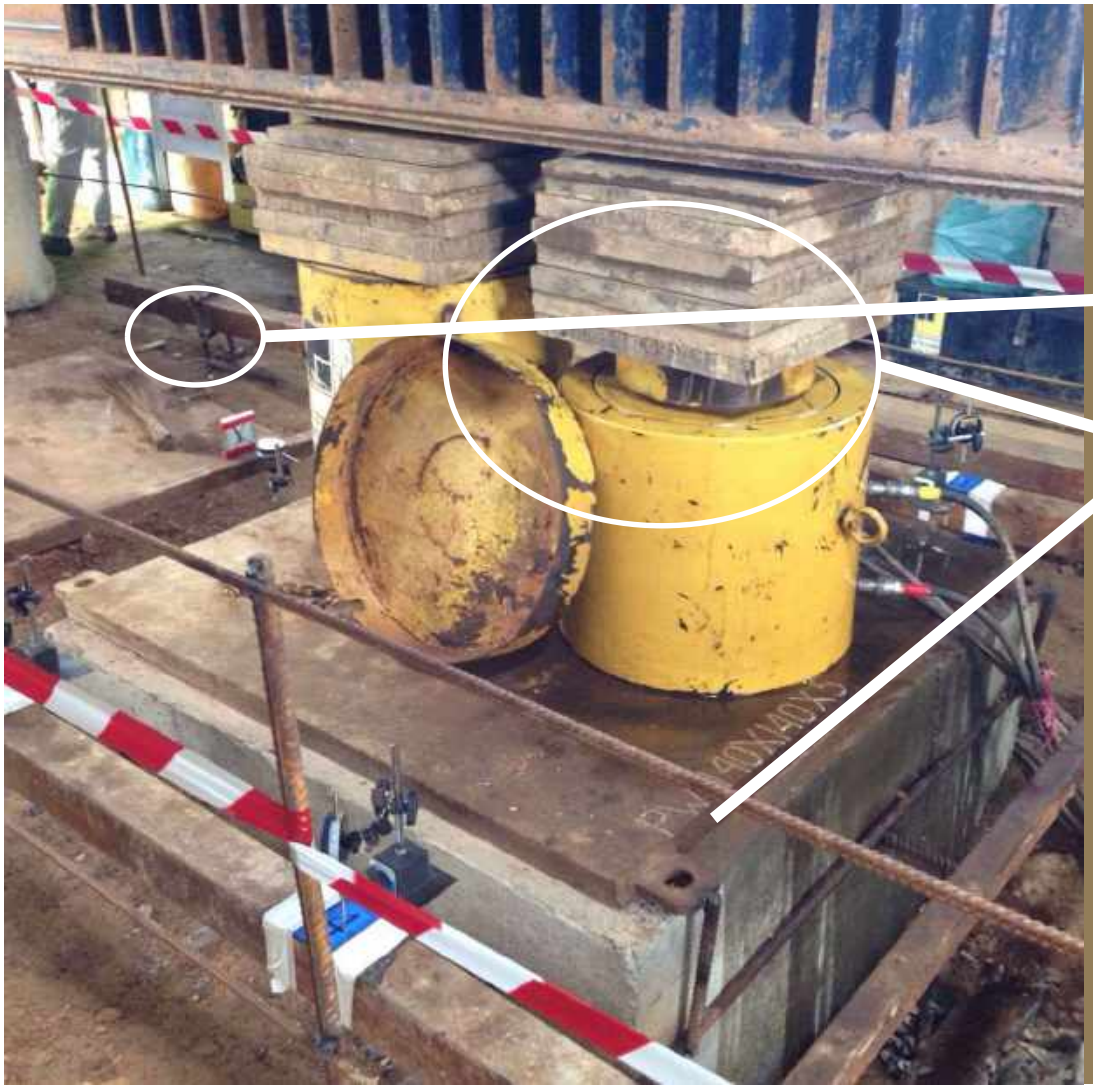
# WHEN THING GOES WRONG!!!

# WHEN THING GOES WRONG!!!

# WHEN THING GOES WRONG!!!

# WHEN THING GOES WRONG!!!

# WHEN THING GOES WRONG!!!



# IS YOUR RESULT VALID?

ASTM D1143-07 (2013)

5.3.1 For tests of single piles, install a solid steel test plate at least 25 mm (1 in.) thick perpendicular to the long axis of the test pile that covers the complete pile top area.

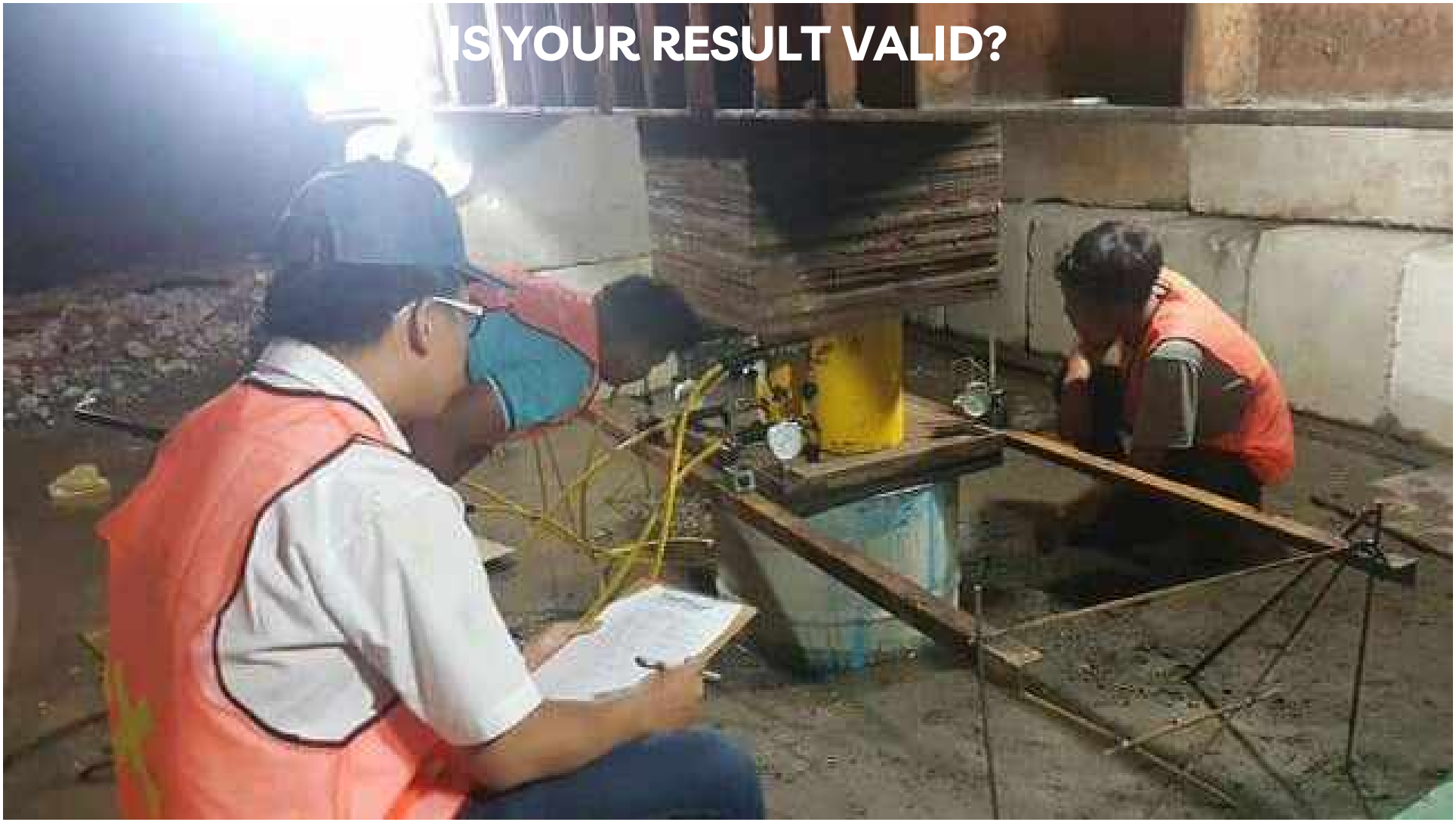
6.2.2.6 If the maximum test load will exceed 900 kN (100 tons), place a properly constructed load cell or equivalent device in series with each hydraulic jack.

6.1.3 Each jack shall include a hemispherical bearing or similar device to minimize lateral loading of the pile or group.

7.1.1 Reference supports shall be located as far as practicable from any crib but not less than a clear distance of 2.5 m (8 ft).

6.2.2.4 When using a multiple jack system, provide jacks of the same made, model and capacity, and supply the jack pressure through a common manifold.

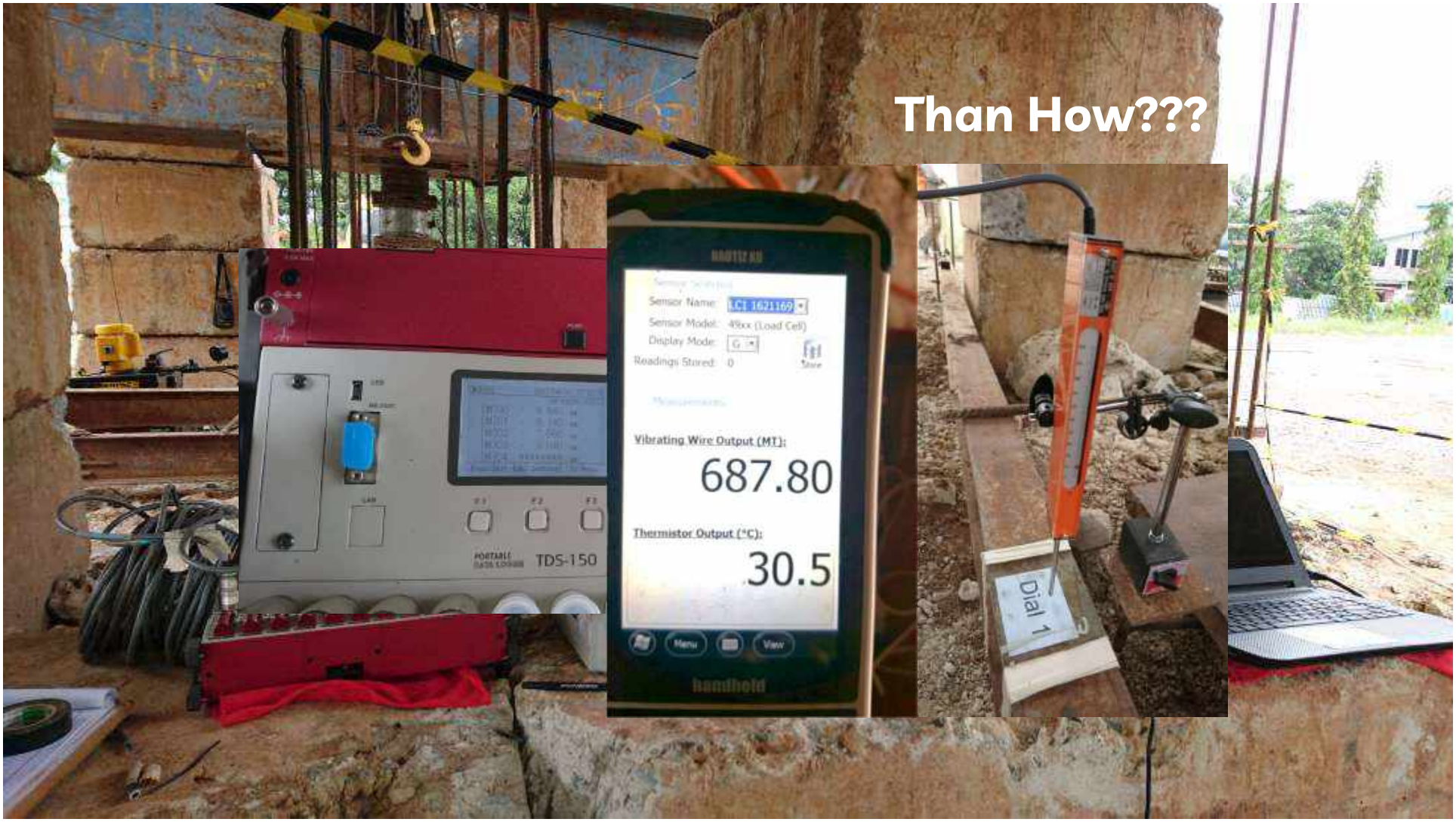
# IS YOUR RESULT VALID?




# IS YOUR RESULT VALID?

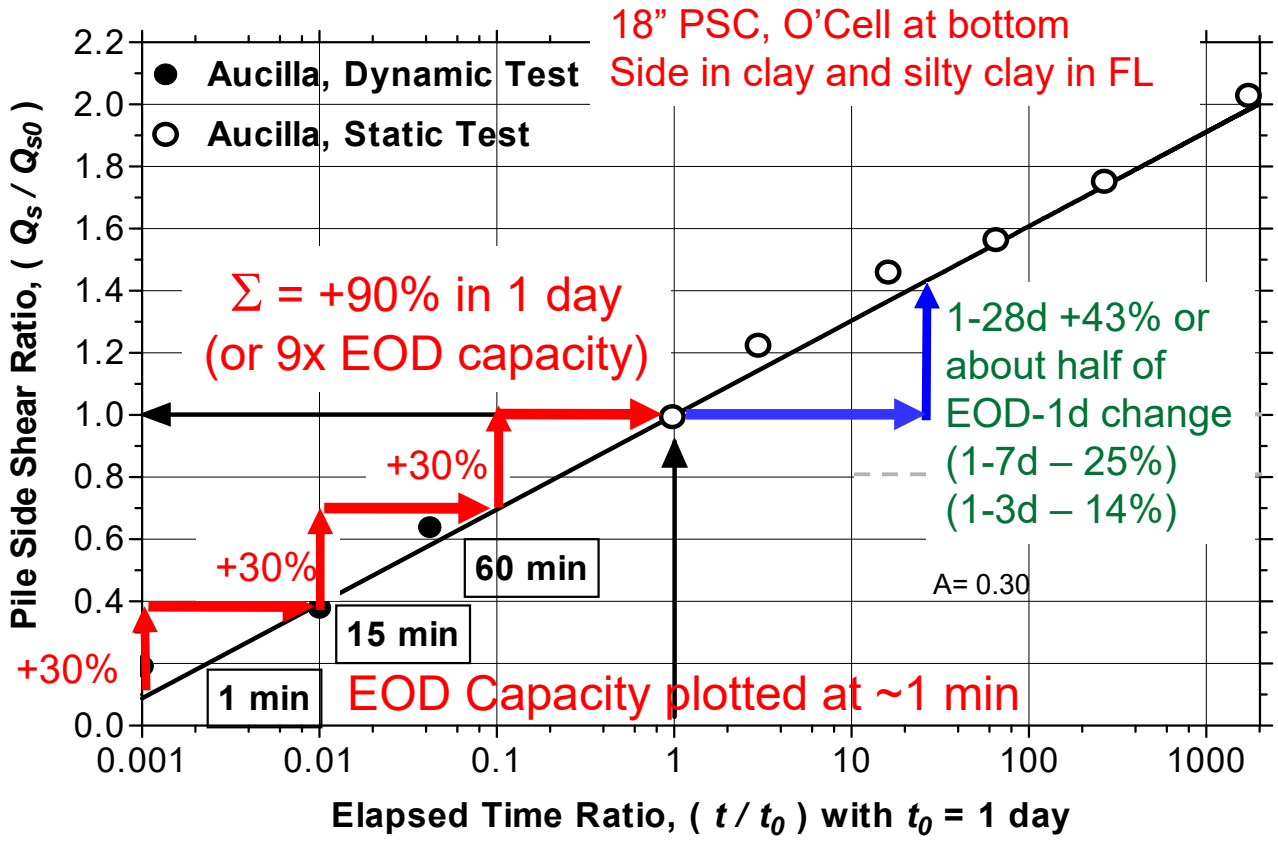
# WHAT YOU SHOULD PAY ATTENTION?

1. Fake Pressure on Manometer
2. Fake Dial Reading
3. Test before the test

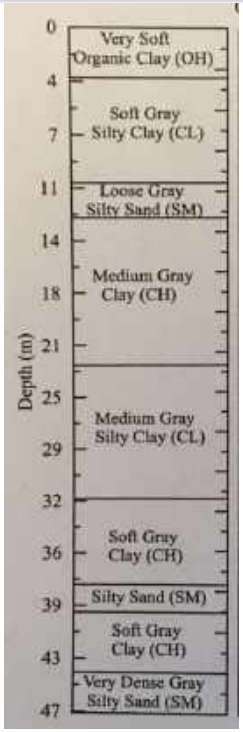

Than How???
TDS-150
Sensor Name:
Sensor Model:
49xx (Load Cell)
Display Mode:
Readings Stored:
0
Store
Vibrating Wire Output (MT):
687.80
Thermistor Output (°C):
30.5
Menu
View
handheld
Dial 1

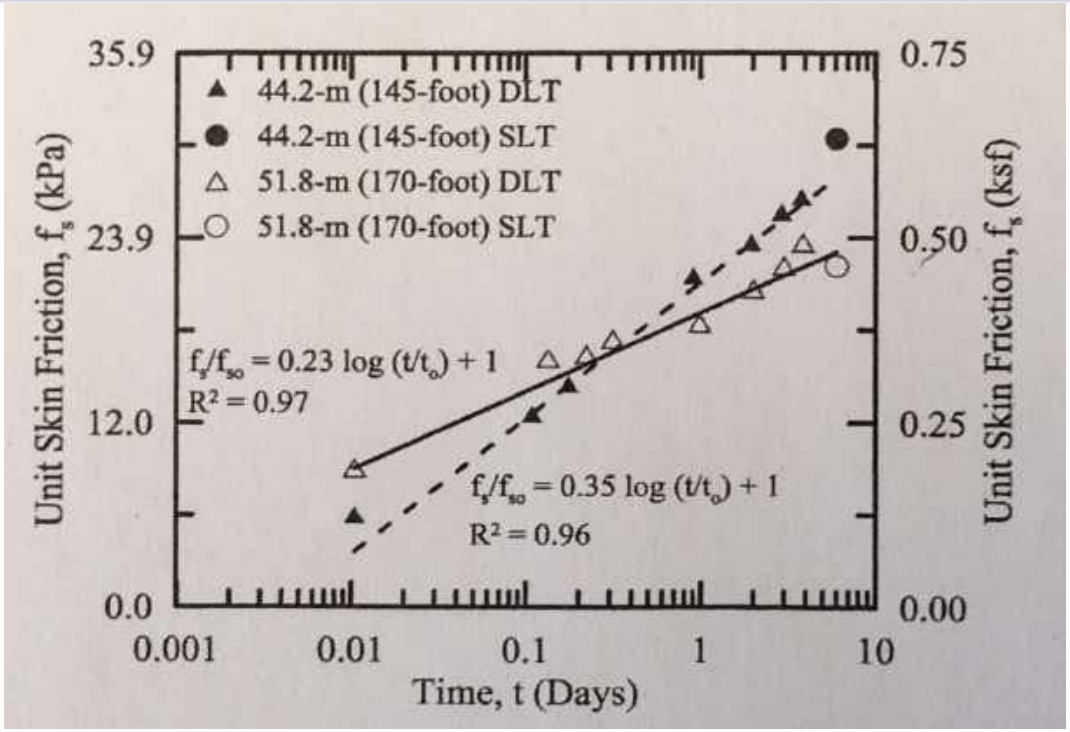

LIGHT RAIL TRANSIT
STATIC AXIAL LOAD TEST
BASED ON ASTM D1143-07 (re-13)
4400 Ton
adhi
OCG - JOPRISS
CIPTA GRAHA ABADI
Foundation Test by:
GEOTECH EFATHAMA
JABODEBEK
Break Time

# Pile Setup Example




Bullock, Schmertmann, McVay, Townsend. "Side Shear Setup", ASCE Geotechnical Journal March 2005

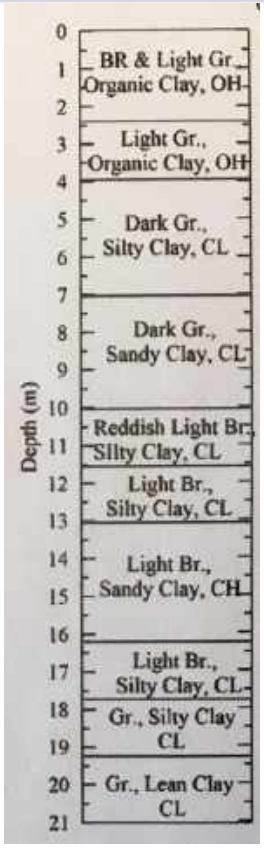


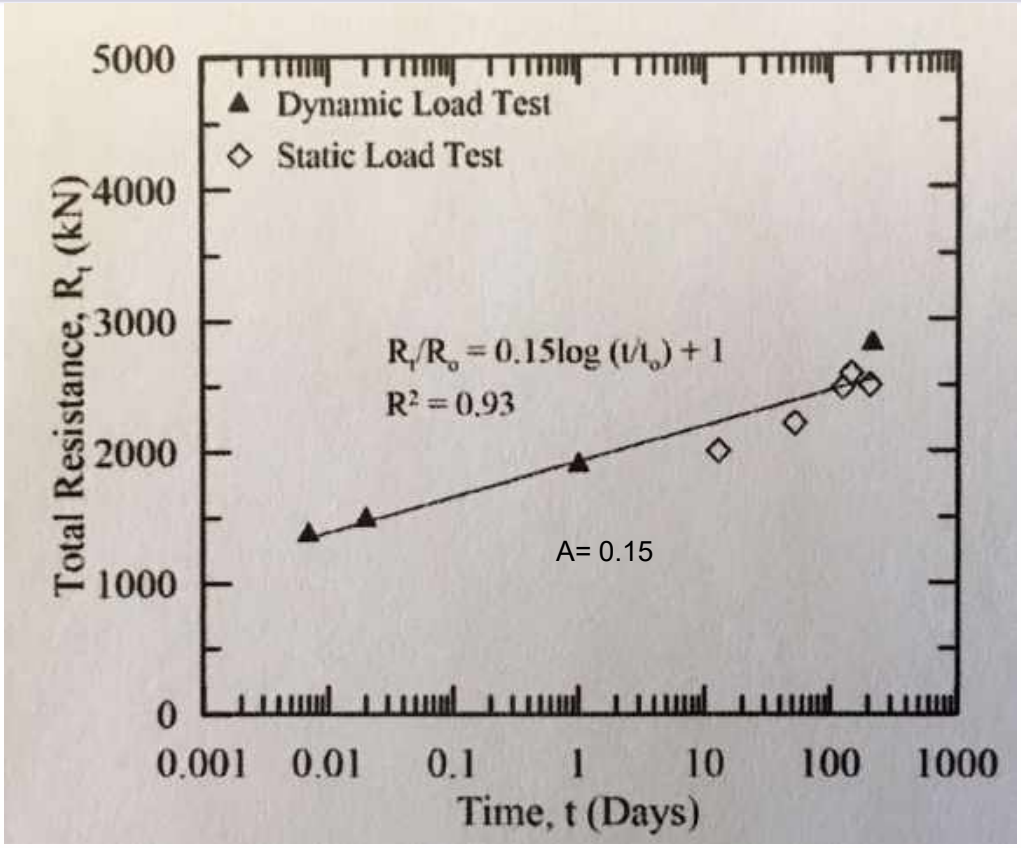




Conclusion: "…the setup curves become log linear with respect to time…as early as 2 hr after EOD… This can help engineers to project the pile resistance at a future time…"

M.N. Haque, M.Y. Abu-Farsakh, C. Tsai, "Field Investigation to Evaluate the Effects of Pile Installation Sequence on Pile Setup Behavior for Instrumented Test Piles" , ASTM Geotechnical Testing Journal, Vol.39, No. 5, Sept. 2016, pp 769-785

Pile Dynamics, Inc.



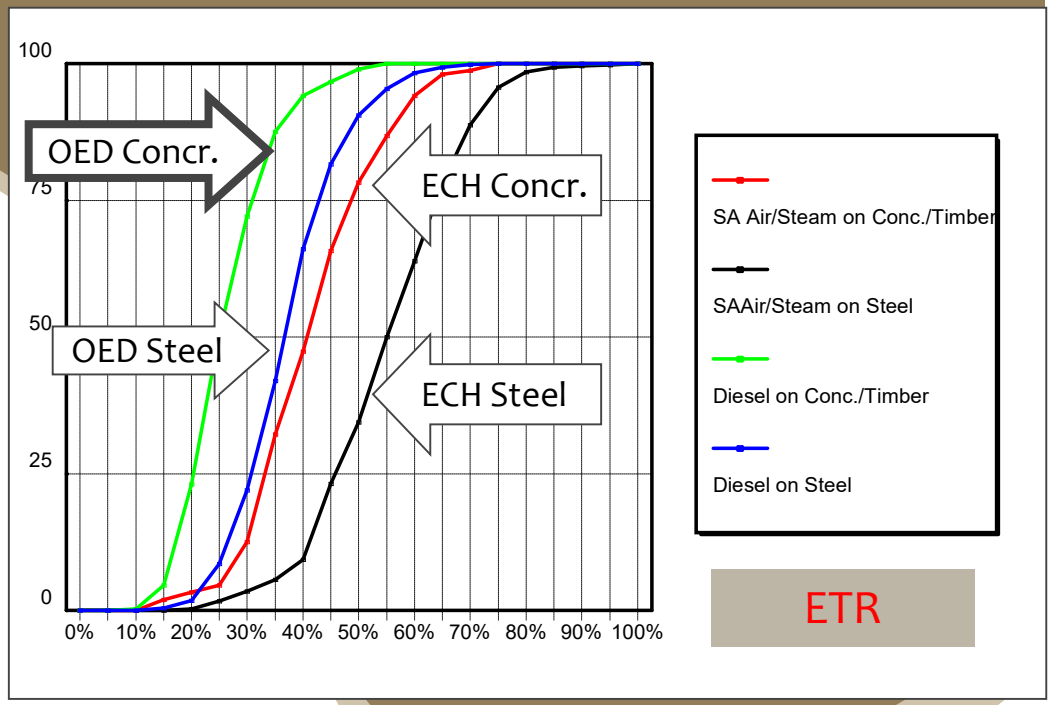

M.Y. Abu-Farsakh, M.N. Haque, Q. Chen, "Experimental Study to Evaluate the Effect of Consolidation Behavior on Pile Setup" , ASTM Geotechnical Testing Journal, Vol.40, No. 4, July 2017, pp 559-578

Pile Dynamics, Inc.

# Hammer Performance

Why is it important?

- Contractor productivity
- To install pile to design depth
- Quality control tool (blow count criteria)




Some hammers (needing repair) have under ha… …he "energy tr… …l ratio" than other good hammers of same make and m…

# Uji Beban Dinamik

# COLLECTING DATA

Testing Preparation

Dapat dilakukan pada semua jenis tiang

**Convert STRAIN ( ε ) to F**

$$F(t) = E A \varepsilon(t)$$

**Convert ACCELERATION to V**

$$V(t) = \int a(t)\, dt$$

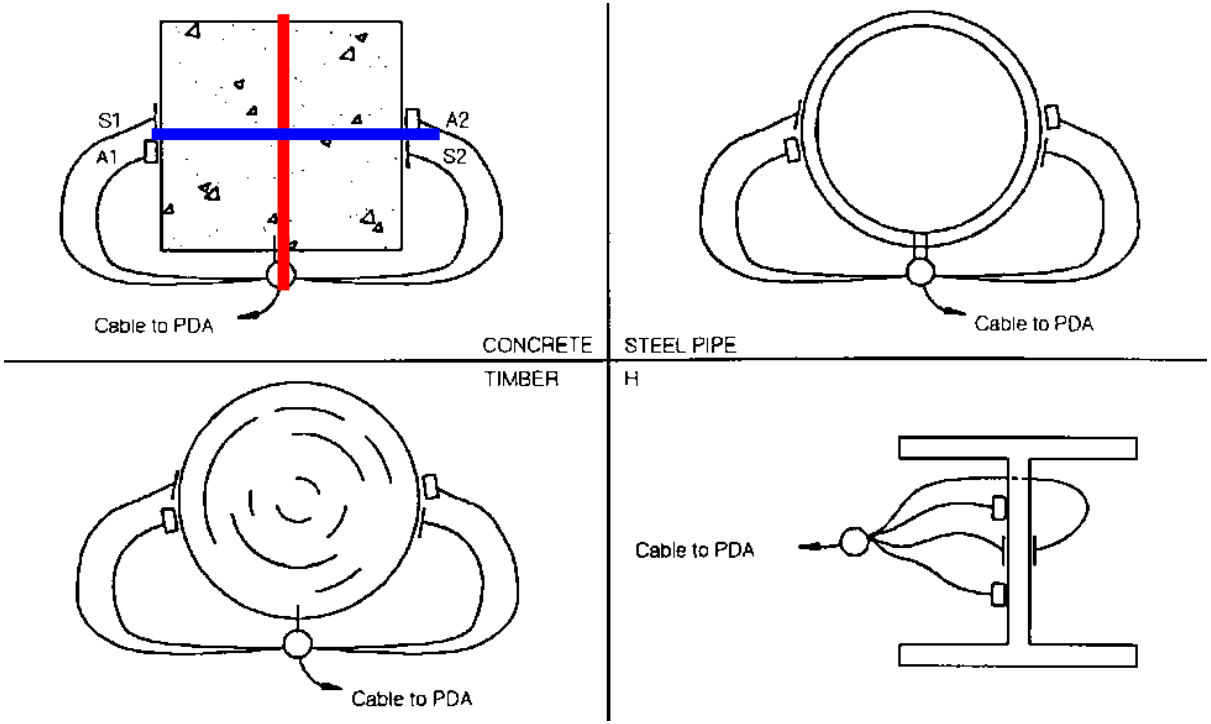
Solution to meet all needs:

lightweight strain and acceleration transducers

***wireless PDA***
***"smart sensors"***
***know their calibration***

# Pengambilan Data (penempatan sensor)

- Perlu minimum 2 *strain* per tiang untuk mengkompensasikan *bending* saat pengujian
  - tempatkan sensor secara simetris terhadap aksis netral
  - perlu 4 strain untuk mengkompensasikan bending pada 2 aksis netral



# Pengambilan Data (penempatan sensor)

Persiapan kepala tiang yang buruk

Pemasangan yang buruk berimbas pada kualitas data

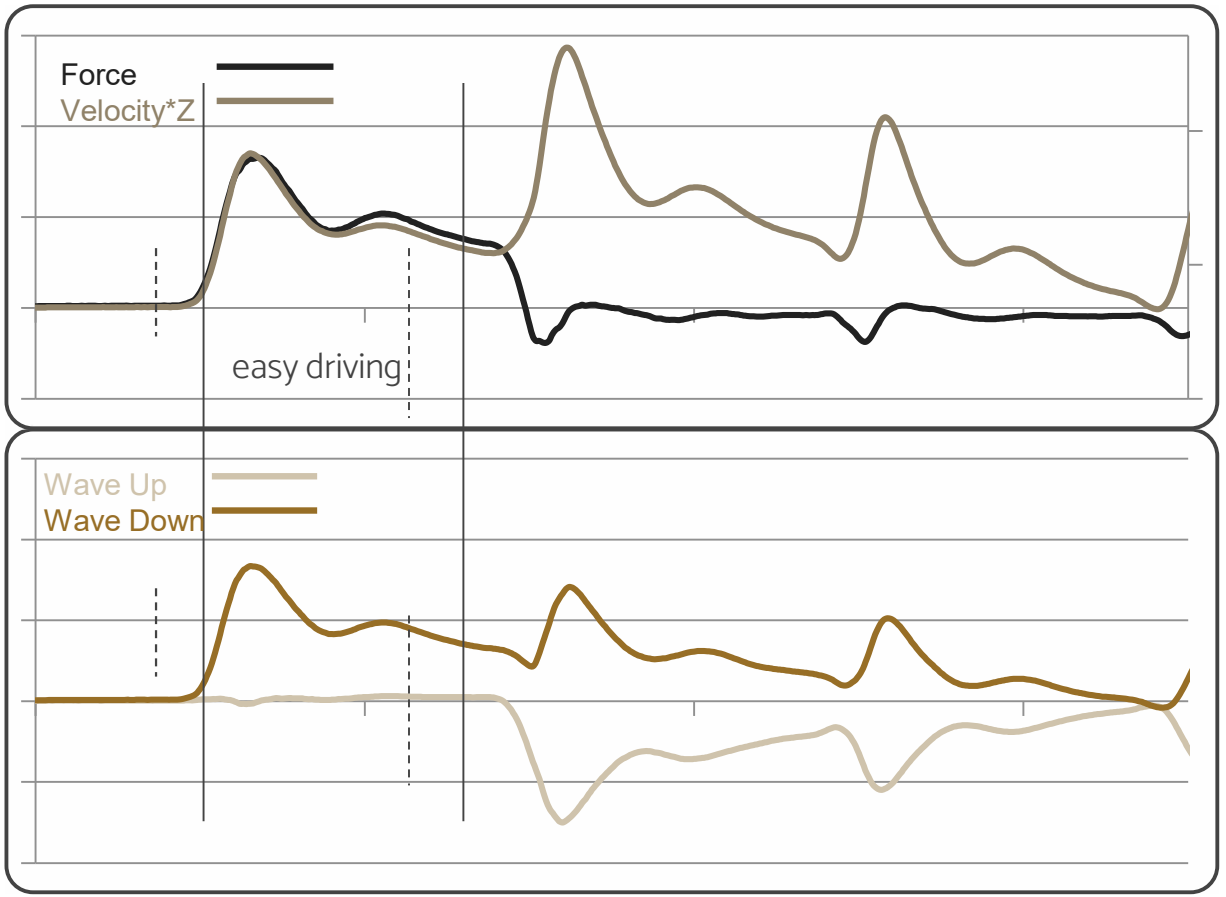
Permukaan yang tidak rata dan lubang bor yang asal-asalan

Posisi sensor tidak berhadapan $180^{O}$ berimbas pada 'bending'

# END-PILE CONDITION

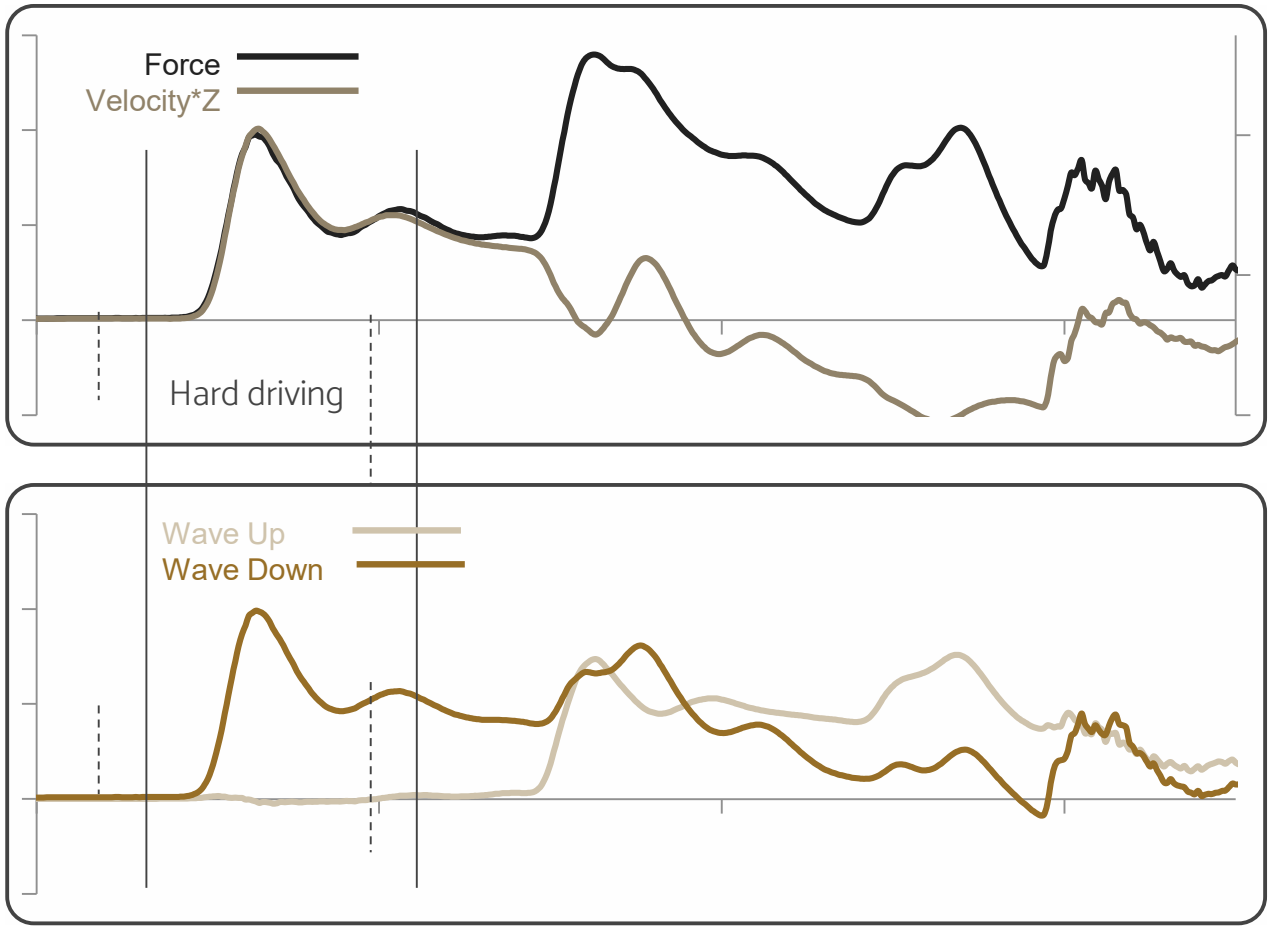
Wave
Mechanics

# Free-end Pile Example



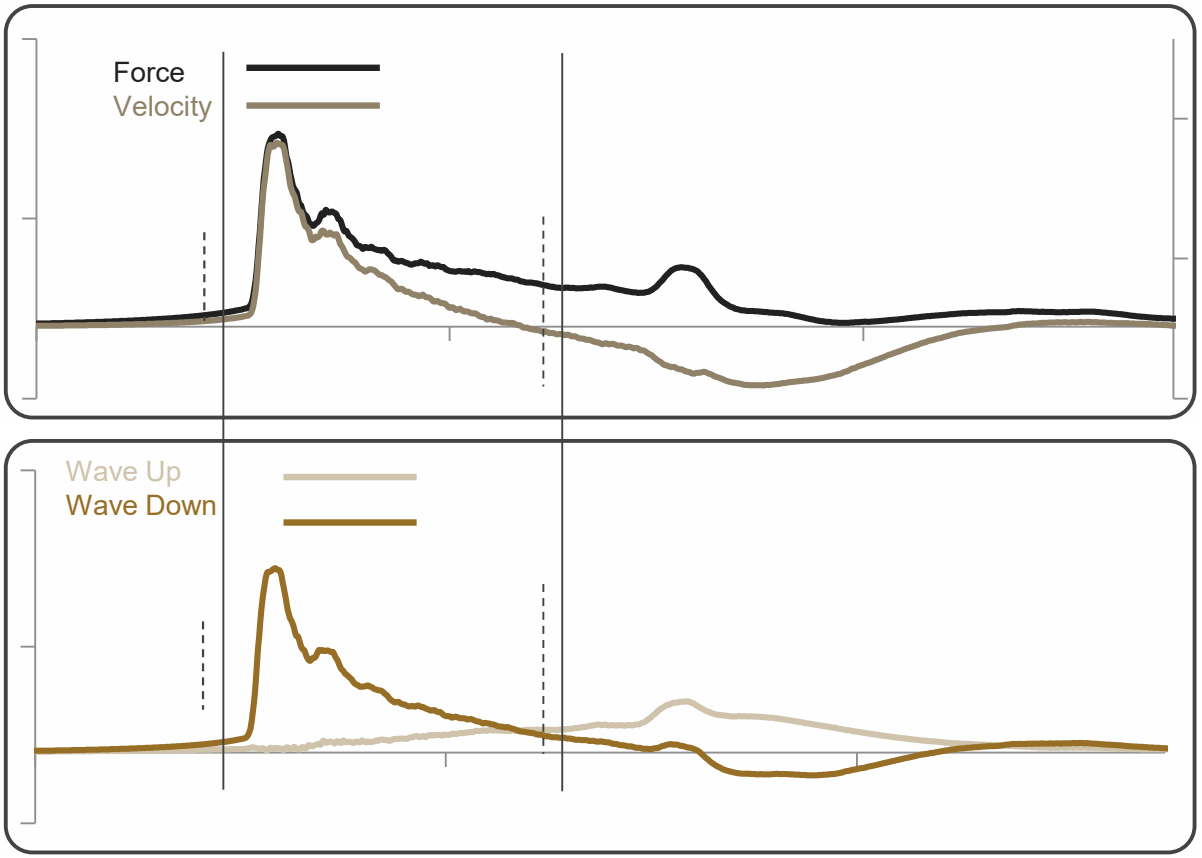
# Free End

## Fixed-end Pile Example

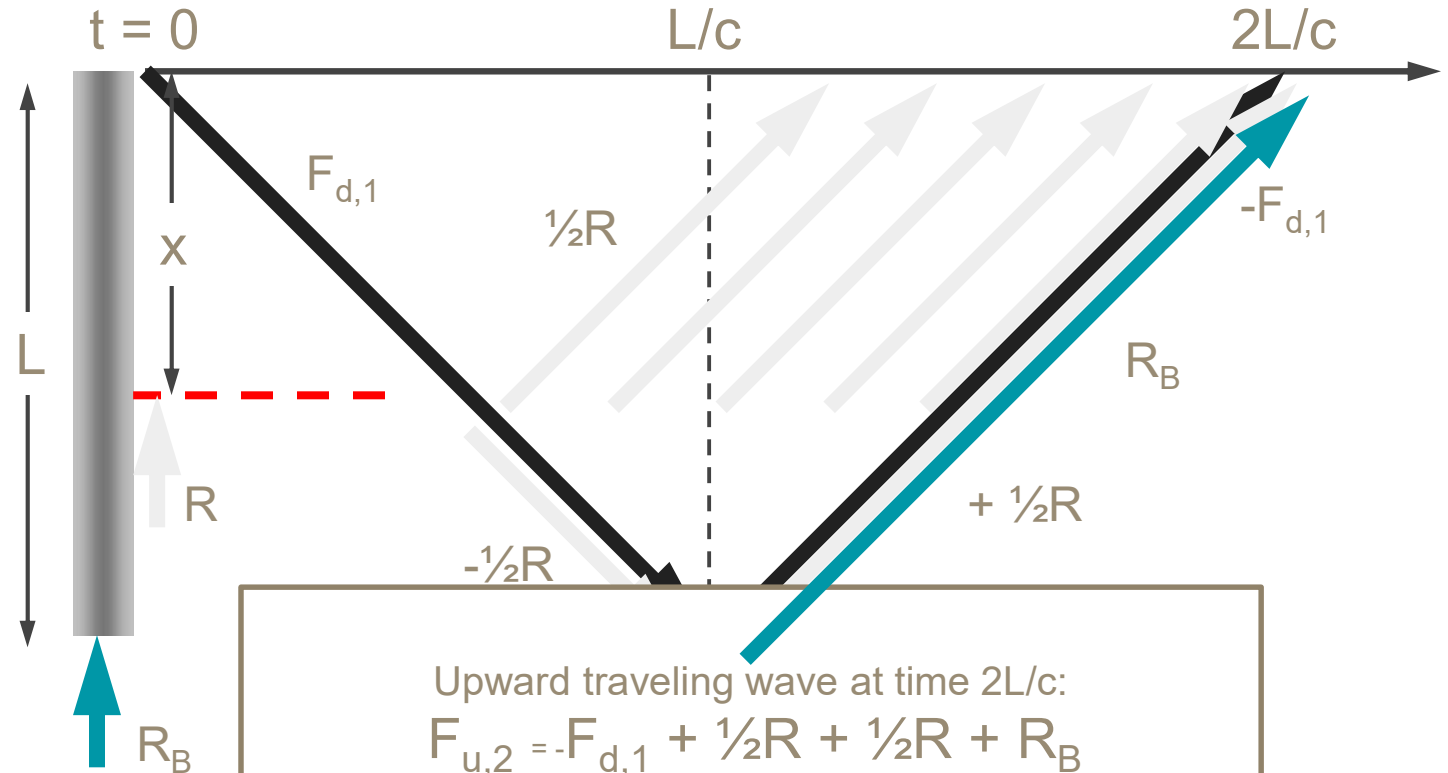


# Fixed End

## Pile with Shaft Resistance Example

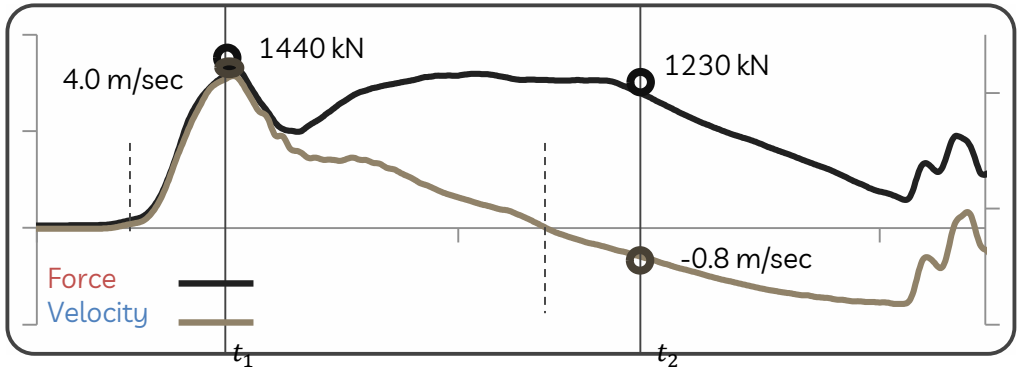


# Case Method - Resistance Waves



# EXAMPLE CAPACITY DETERMINATION

(SI units)




PILE: 355 mm O.D. x
8 mm wall pipe pile

Area: 83.3 $cm^2$
E: 207,000 MPa
C: 5,123 m/s

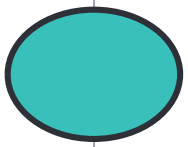
Clay Soils
Assume Jc: 0.9

$$Z = \frac{EA}{c} = \frac{210MPa\ (83.3cm^2)}{5{,}123\ ^{m}/_{sec}} = 336\ ^{kN\ sec}/_{m}$$

$$R_{static} = (1 - Jc)[F_{@t_1} + Zv_{@t_1}]/2\ +\ (1 + Jc)[F_{@t_2} - Zv_{@t_2}]/2$$

$$R_{static} = (1 - 0.9)\left(\frac{1440 + 336(4.0)}{2}\right) + (1 + 0.9)\left(\frac{1230 - 336(-0.8)}{2}\right)$$

$$R_{static} = 1563\ kN$$



# Uji Integritas

# Why Test?

- Duty of Care to the public to build safe structures.
- An ounce of prevention is worth a pound of cure. We spend lots of money. Testing is cheap compared to remediation.
- Uncertainty in foundation
  → Increases Risk
- Testing answers unknowns
  → Reduces Risk

# Why Test?

Defects aren't uncommon for pile construction

# Why Test?

Augercast pile failed static test due to defect

# Integrity – Deep Foundations

## What ?

- Driven Piles
- Drilled Shafts
- CFA – Augercast Piles

## When ?

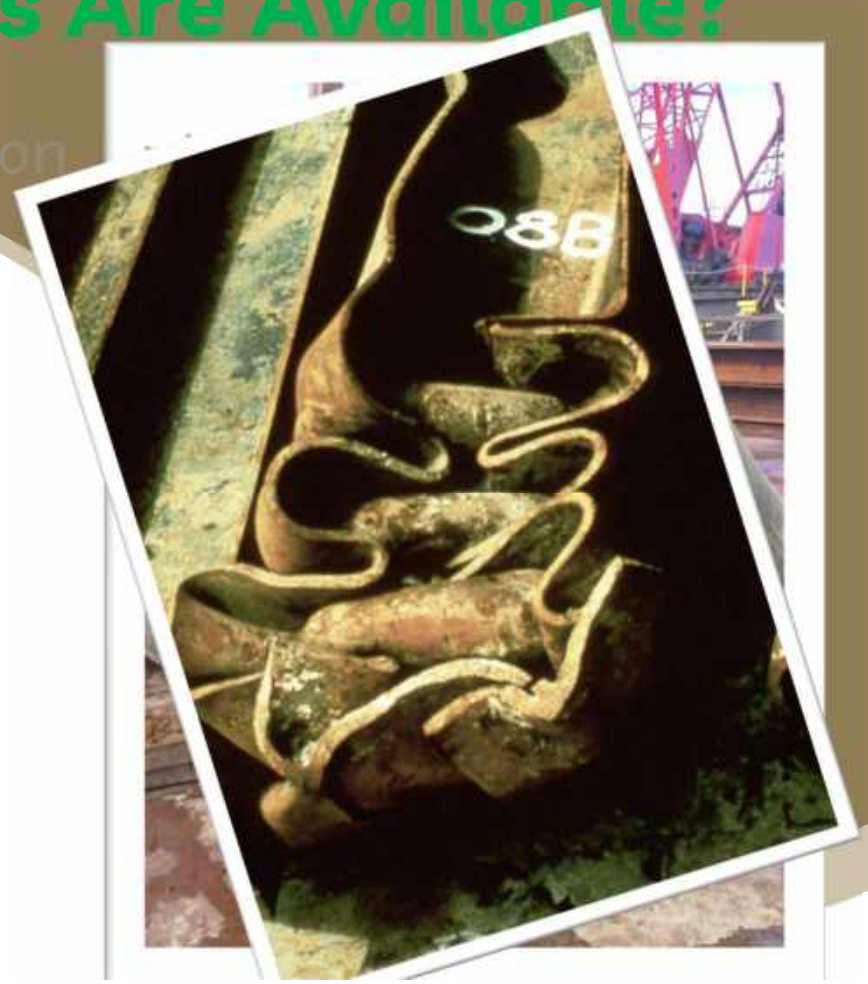
- Test during installation
- Test soon after installation
- Test existing foundation (years after installed)
  - Element free from structure ?
  - Element embedded in structure ?

# What Tools Are Available?

- Visual Inspection

# What Tools Are Available?

- Visual Inspection
  - Extraction



# What Tools Are Available?

- Visual Inspection
  - Extraction

# What Tools Are Available?

- Visual Inspection
  - Extraction
- Sample Testing
  - i.e., - Coring
- Non-Destructive Testing

# What Tools Are Available?

- Non-Destructive Testing:
  - High Strain Integrity Testing
  - Low Strain Integrity Testing
    - Pulse Echo / Transient Response
  - Automated Monitoring Equipment
  - Cross-hole Sonic Logging
    - Single-hole Sonic Logging
  - Thermal Integrity Profiling

# High Strain Integrity Testing

## Advantages

- Generally definitive integrity answers
- Stress information to avoid damage
- Assesses pile capacity at same time
  - Only NDT method with this ability

## Limitations / Disadvantages

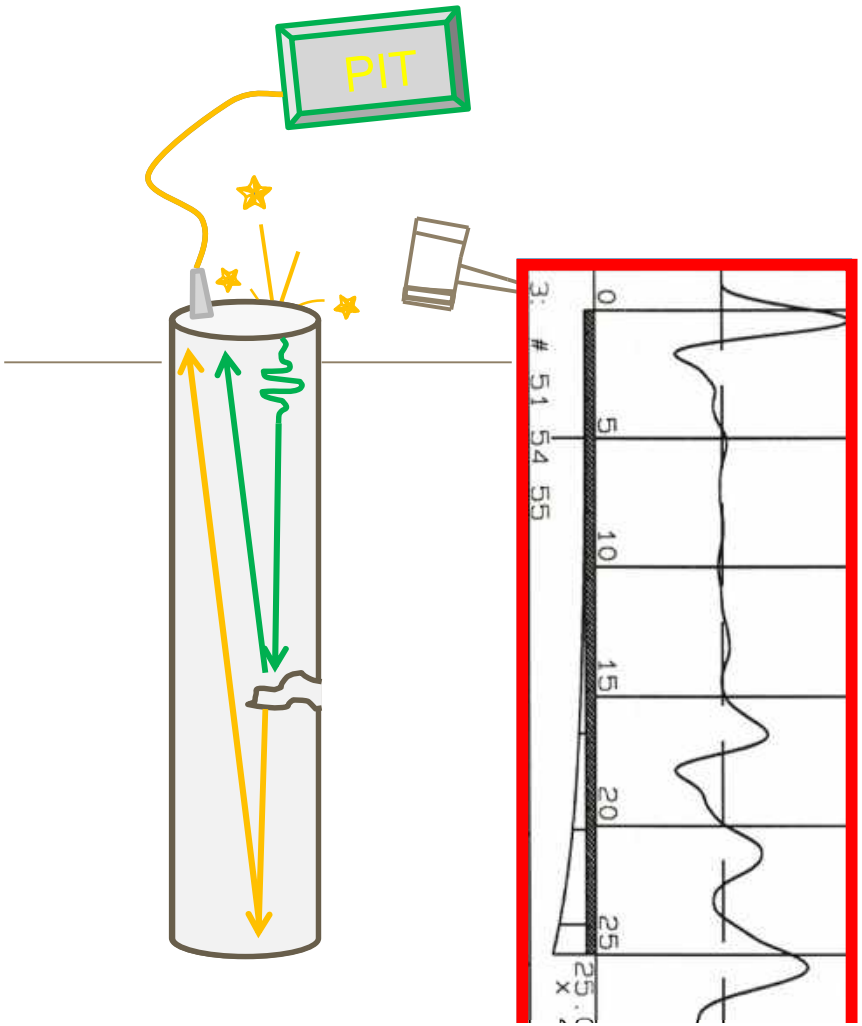
- Best use: uniform Driven Piles
  - Driven pile integrity usually not of concern
- Relatively high cost

# Low Strain Integrity Testing

- Pile Integrity Test (time domain)
- Sonic Integrity Test
- Impact Echo
- Pulse Echo

- Transient Response (frequency domain)

- Application to solid concrete sections
  - (main use: augercast piles and drilled shafts)




# Konsep

**M**enggunakan gelombang yang merambat dari kepala tiang ke dasar tiang dan dipantulkan kembali ke atas.

# Pile Preparation

**Remove fractured or contaminated concrete**

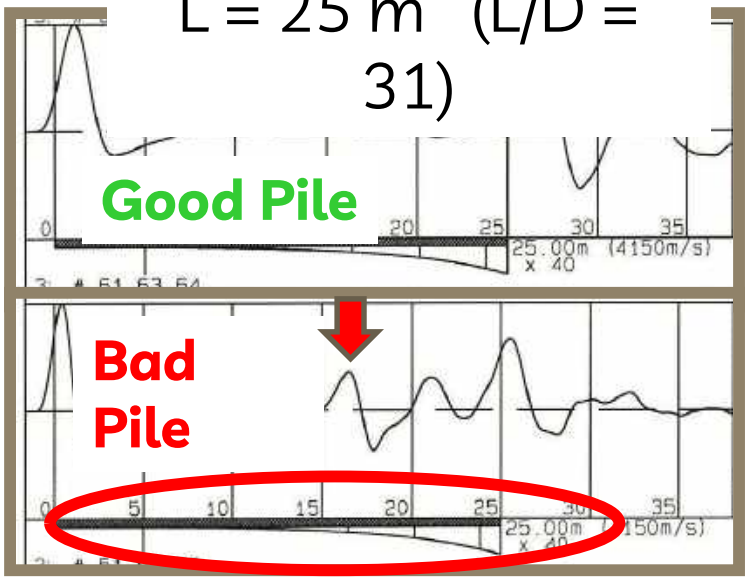
**Grind a flat spot to attach accelerometer**

# PIT – Basic Interpretation

**Normal test (pile top "free")**

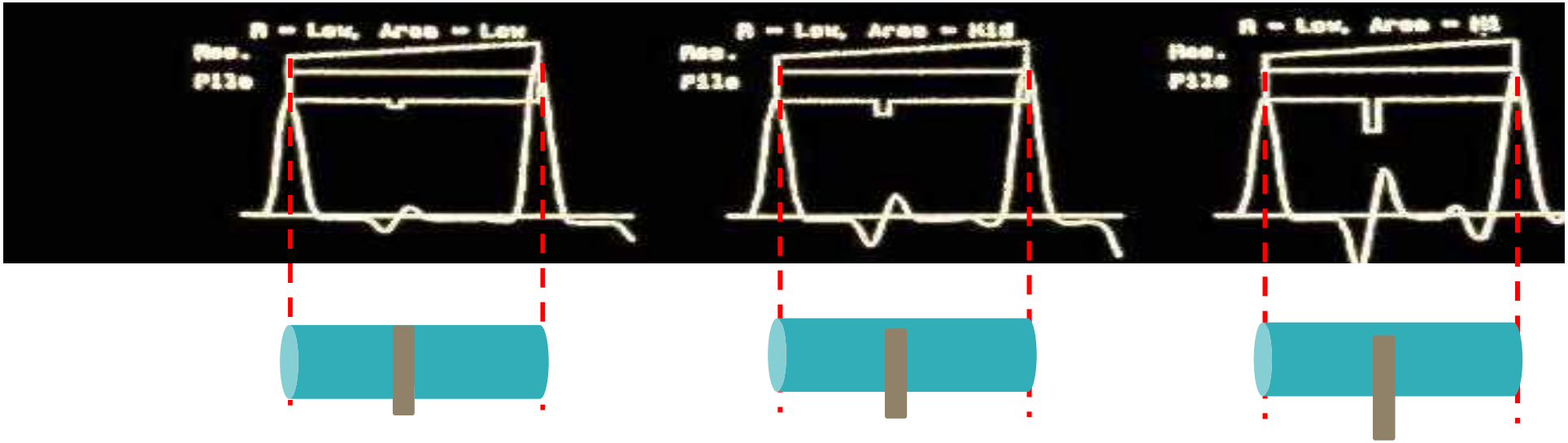
800 mm drilled shafts

L = 25 m (L/D = 31)




**Exponential signal amplification**

# Interpretasi Hasil

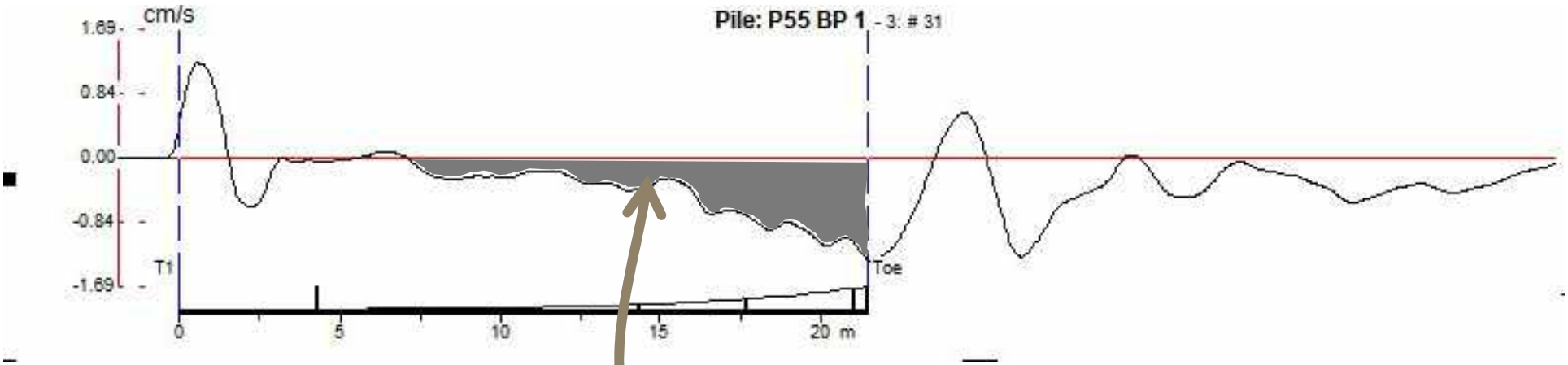


**Local Bulge:** **small** **medium** **large**

# Classification of Results

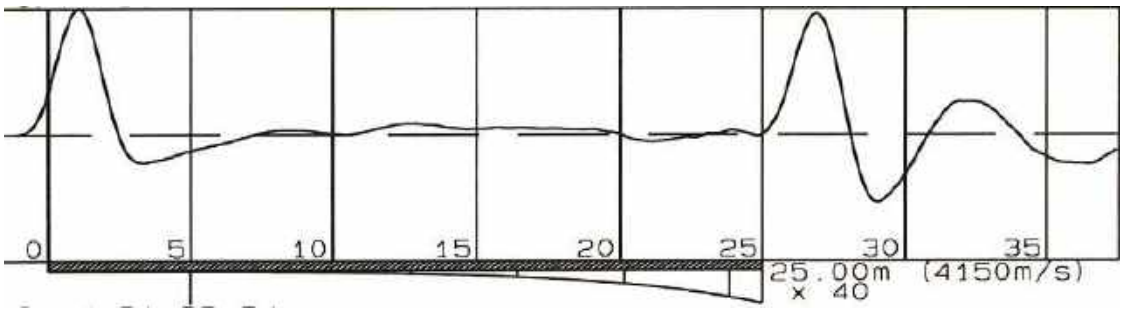
- **AA – Good pile, clear toe**
- **ABx – No defect to Depth x, no toe signal**
  **(long pile, high resistance, major bulges)**
- **PFx – Probable Flaw at Depth x, toe apparent**
- **PDx – Probable Defect at Depth x, no toe signal**
- **IVx – Inconclusive below Depth x due to**
  **Vibrations (machinery, reinforcement)**
- **IR – Inconclusive Record**

# Interpretasi Hasil



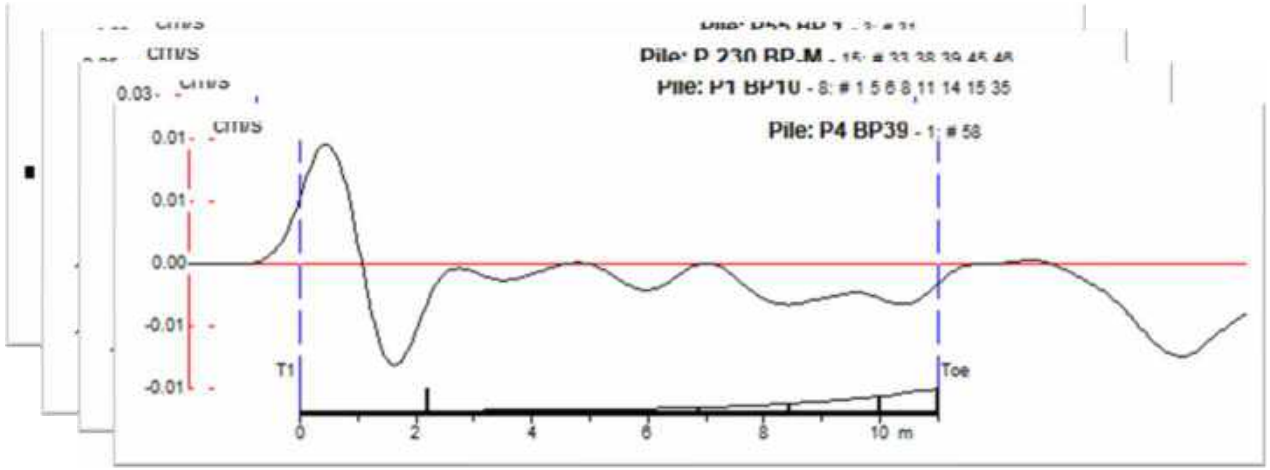

Pengaruh dari konsistensi tanah

# Integritas Tiang Baik

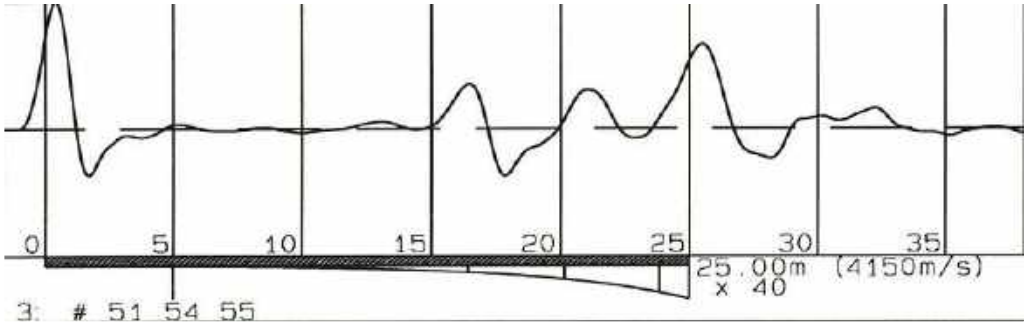



Ideal

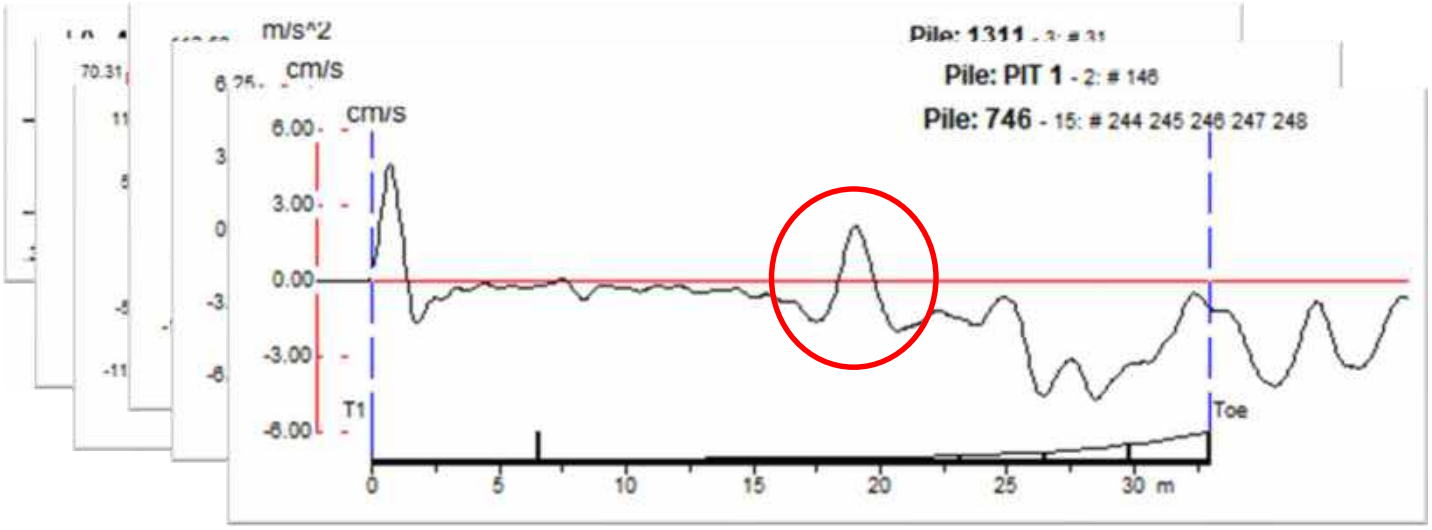
Kenyataan



# Integritas Tiang Buruk

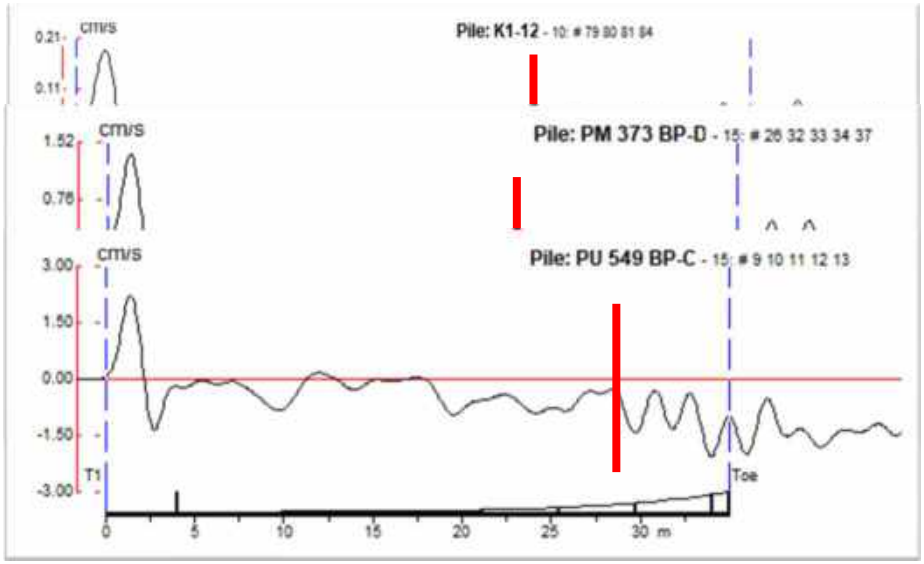



Ideal

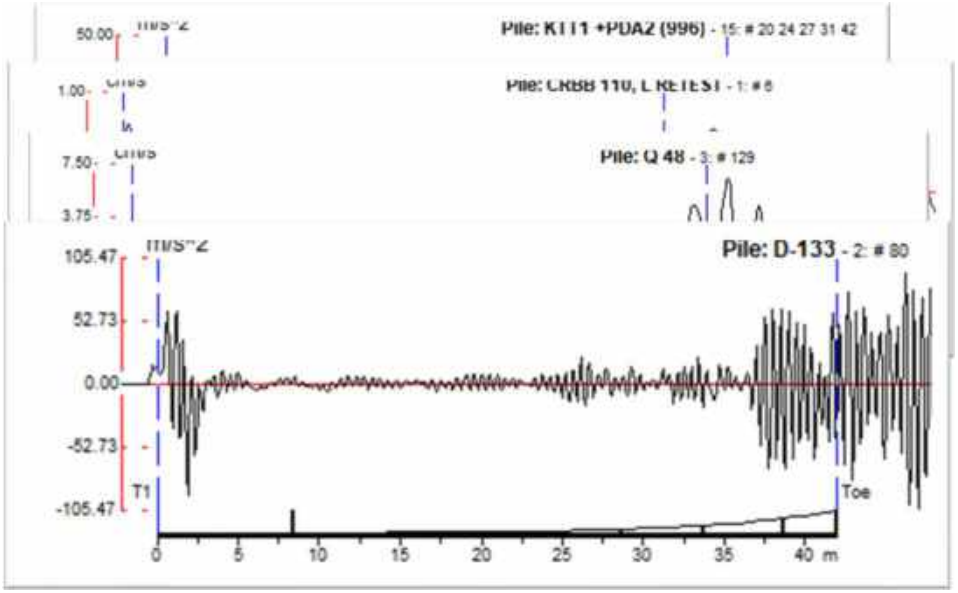



Ada perubahan impedansi yang signifikan

# Integritas = ???




Data hanya bisa di analisa sebagian




Data Buruk

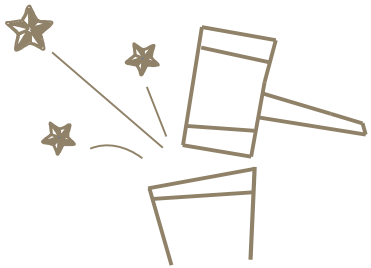
# WHY?

# Kelebihan vs Kekurangan

**Mudah untuk melakukan tesnya**

**Analisa sulit dan hasil yang terlalu subyektif**

**Tidak memerlukan akses pipa**

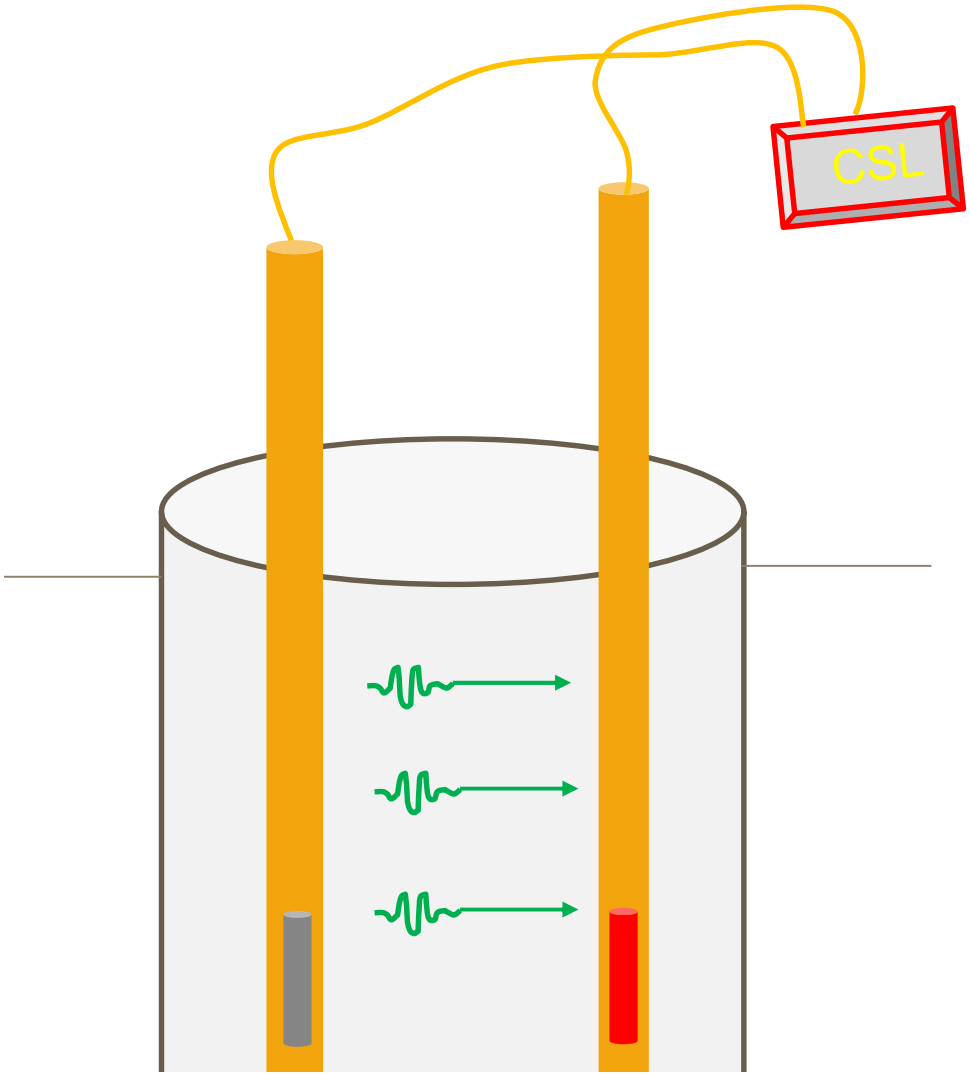


**Konsistensi tanah bisa mempengaruhi hasil**

**Bisa dilakukan pada tiang bor maupun pancang *existing***

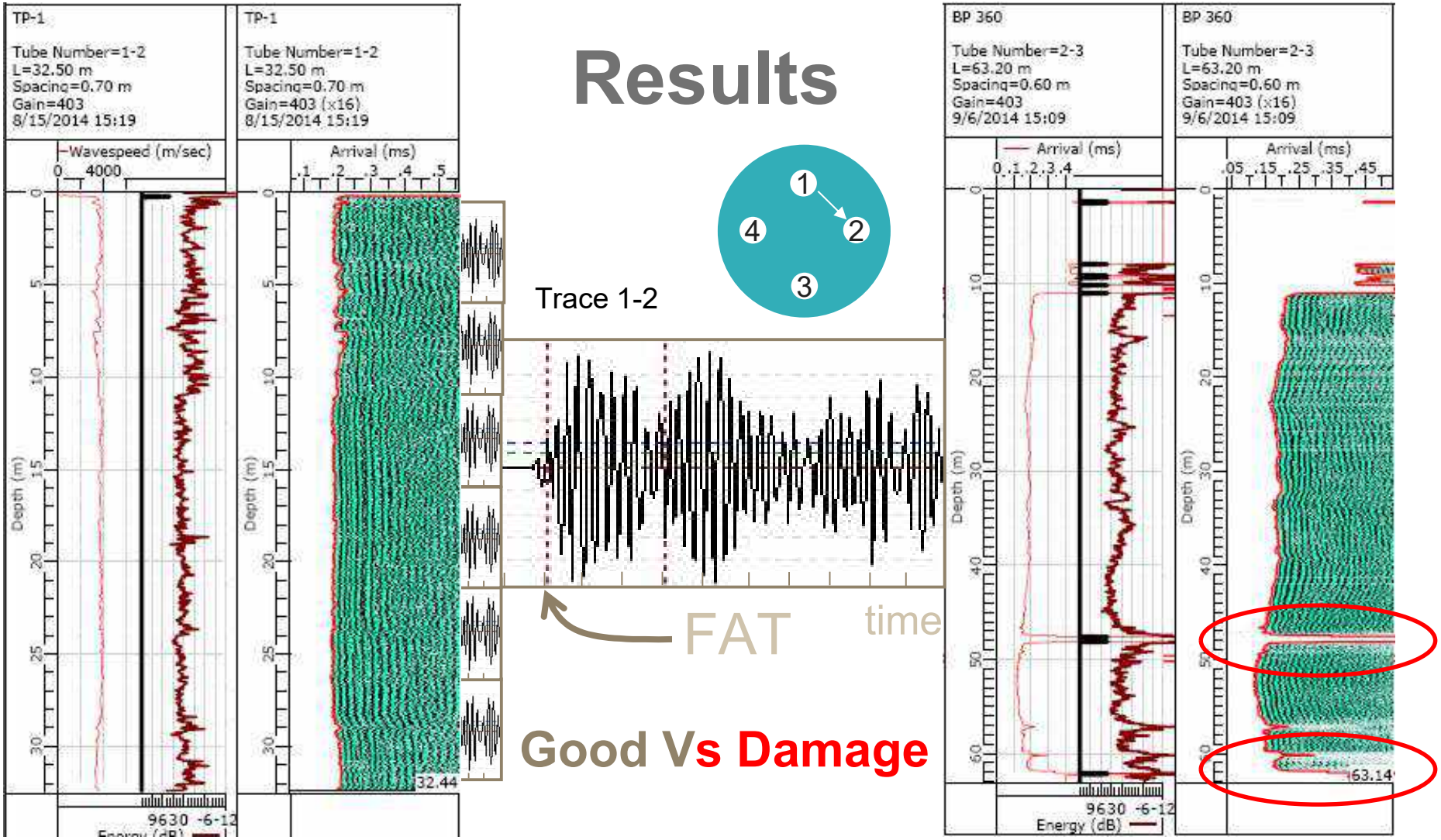
**Hanya bisa melihat kerusakan pada 1 lokasi saja**

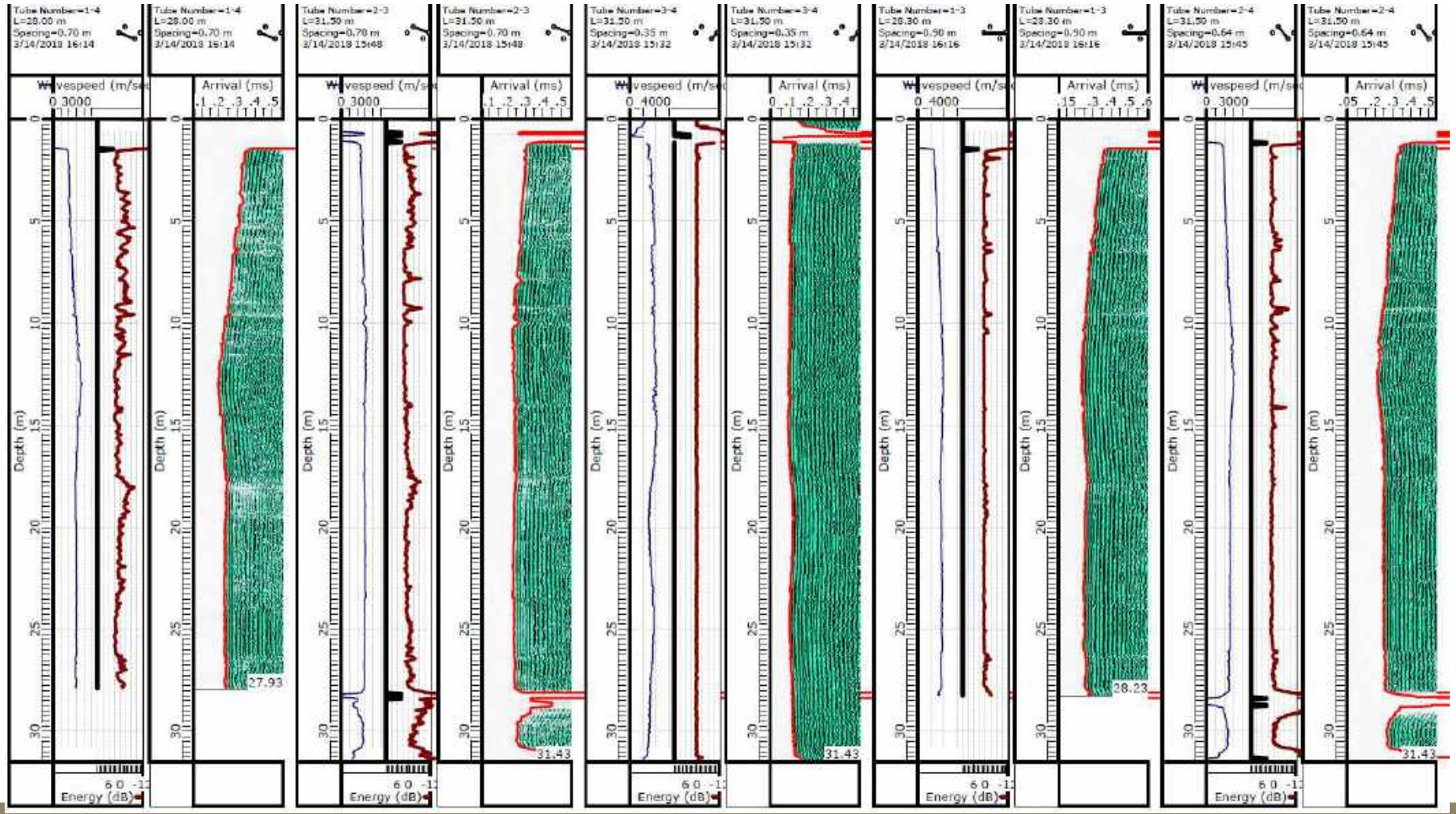
# 2. Cross-Hole Sonic Logging (CSL)



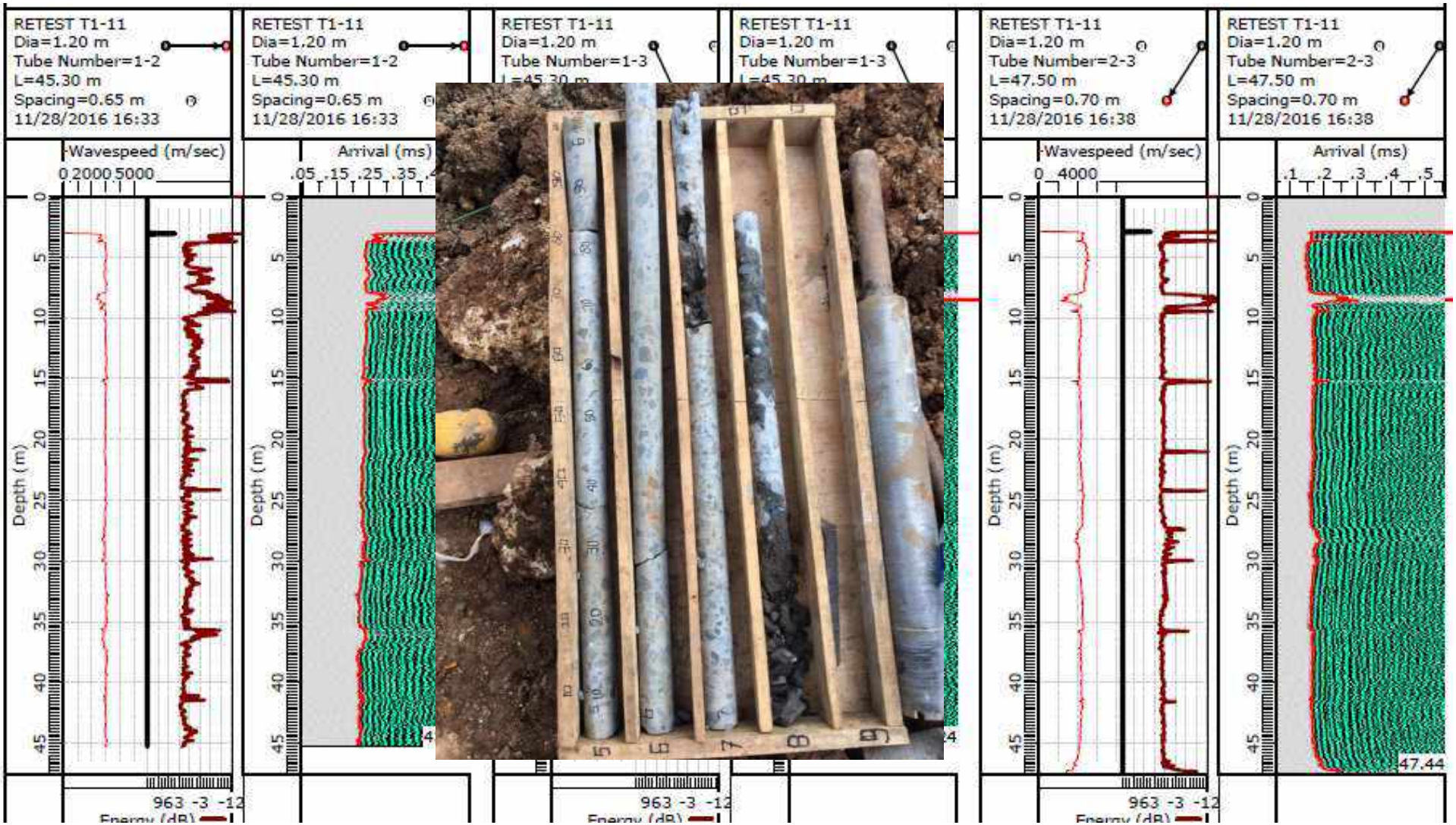

# Konsep

Sensor Transmitter mengirim sinyal ke sensor receiver di sepanjang tiang dan mengecek integritas dari kecepatan rambat dan waktu transmisi gelombang antar sensor.


TP-1
Tube Number=1-2
L=32.50 m
Spacing=0.70 m
Gain=403
8/15/2014 15:19
Wavespeed (m/sec)
0 4000
Depth (m)
9630 -6-12
TP-1
Tube Number=1-2
L=32.50 m
Spacing=0.70 m
Gain=403 (x16)
8/15/2014 15:19
Arrival (ms)
.1 .2 .3 .4 .5
32.44
Results
1
2
3
4
Trace 1-2
FAT
time
Good Vs Damage
BP 360
Tube Number=2-3
L=63.20 m
Spacing=0.60 m
Gain=403
9/6/2014 15:09
Arrival (ms)
0 .1 .2 .3 .4
Energy (dB)
BP 360
Tube Number=2-3
L=63.20 m
Spacing=0.60 m
Gain=403 (x16)
9/6/2014 15:09
Arrival (ms)
.05 .15 .25 .35 .45
63.14


Tube Number=1-4
L=28.00 m
Spacing=0.70 m
3/14/2018 16:14
Wavespeed (m/sec)
0 3000
Arrival (ms)
.1 .2 .3 .4 .5
27.93
Tube Number=1-4
L=28.00 m
Spacing=0.70 m
3/14/2018 15:14
Tube Number=2-3
L=31.50 m
Spacing=0.70 m
3/14/2018 15:48
Tube Number=2-3
L=31.50 m
Spacing=0.70 m
3/14/2018 15:48
31.43
Tube Number=3-4
L=31.50 m
Spacing=0.35 m
3/14/2018 15:32
0 4000
Tube Number=3-4
L=31.50 m
Spacing=0.35 m
3/14/2018 15:32
Tube Number=1-3
L=28.30 m
Spacing=0.90 m
3/14/2018 16:16
Tube Number=1-3
L=28.30 m
Spacing=0.90 m
3/14/2018 16:16
.15 .3 .4 .5 .6
28.23
Tube Number=2-4
L=31.50 m
Spacing=0.64 m
3/14/2018 15:45
Tube Number=2-4
L=31.50 m
Spacing=0.64 m
3/14/2018 15:45
.05 .2 .3 .4 .5
Depth (m)
0 5 10 15 20 25 30
Energy (dB)
60 -11

# Good Pile Preparations

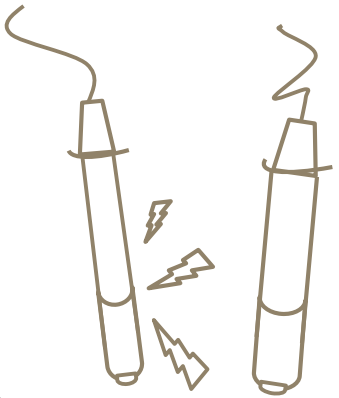

RETEST T1-11
Dia=1.20 m
Tube Number=1-2
L=45.30 m
Spacing=0.65 m
11/28/2016 16:33
Wavespeed (m/sec)
0 2000 5000
Depth (m)
963 -3 -12
RETEST T1-11
Dia=1.20 m
Tube Number=1-2
L=45.30 m
Spacing=0.65 m
11/28/2016 16:33
Arrival (ms)
.05 .15 .25 .35
RETEST T1-11
Dia=1.20 m
Tube Number=1-3
RETEST T1-11
Dia=1.20 m
Tube Number=1-3
RETEST T1-11
Dia=1.20 m
Tube Number=2-3
L=47.50 m
Spacing=0.70 m
11/28/2016 16:38
Wavespeed (m/sec)
0 4000
RETEST T1-11
Dia=1.20 m
Tube Number=2-3
L=47.50 m
Spacing=0.70 m
11/28/2016 16:38
Arrival (ms)
.1 .2 .3 .4 .5
47.44

# Kelebihan vs Kekurangan

**Interpretasi mudah dipahami**

**Cek kerusakan di beberapa lokasi**

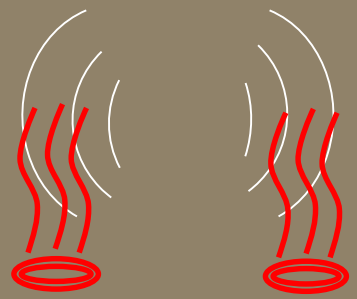
**Tidak dipengaruhi konsistensi tanah sekitar**



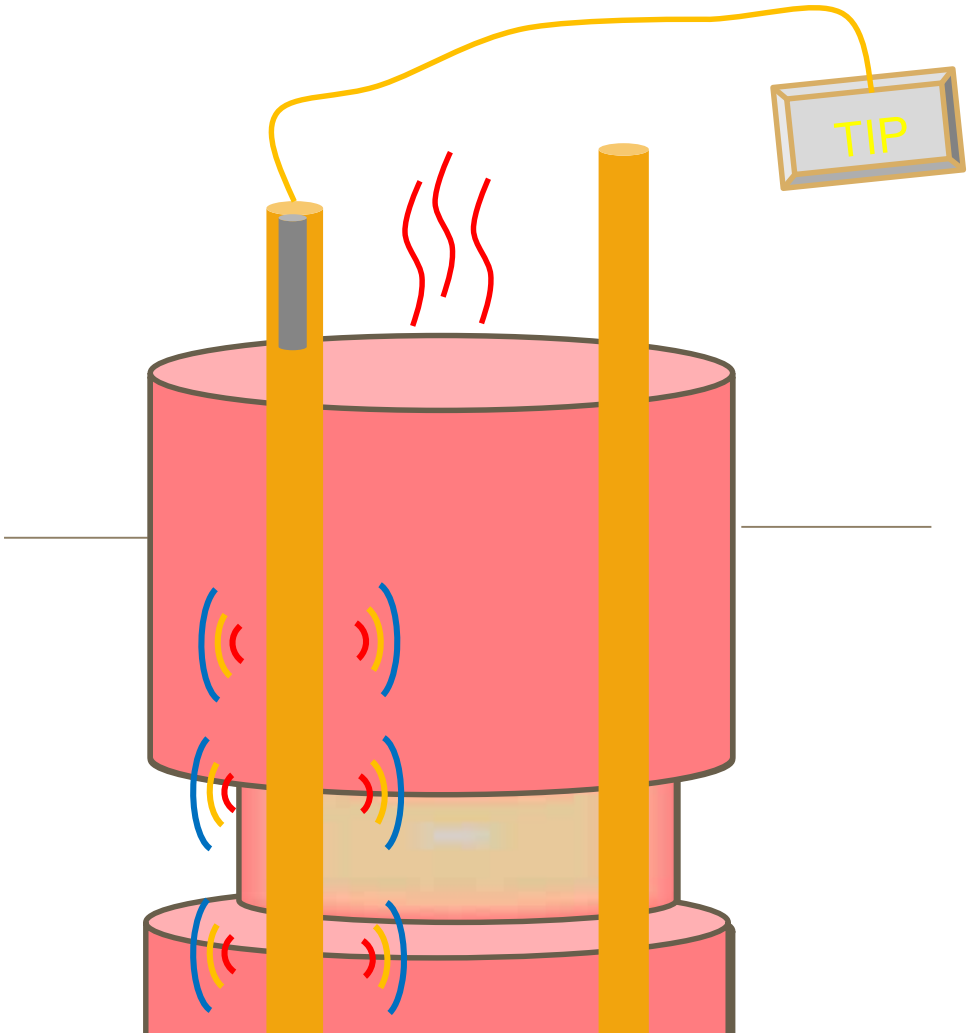
**Hanya bisa dilakukan pada tiang *cast in-situ***

**Mengetahui kerusakan antara kedua pipa akses**

**Tidak dapat mengetahui kerusakan yang ada di selimut tiang**



# 3. Thermal Integrity Profiler (TIP)

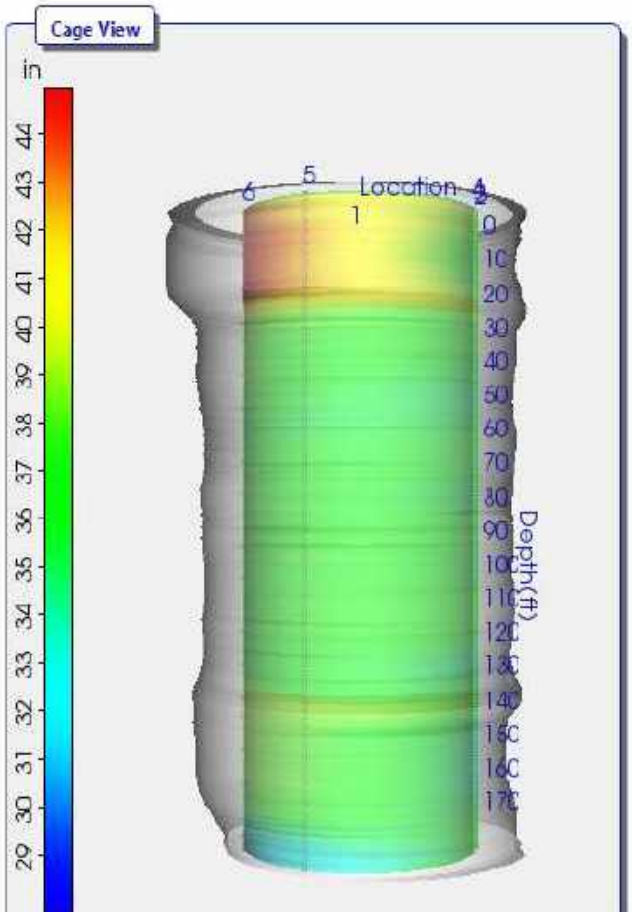


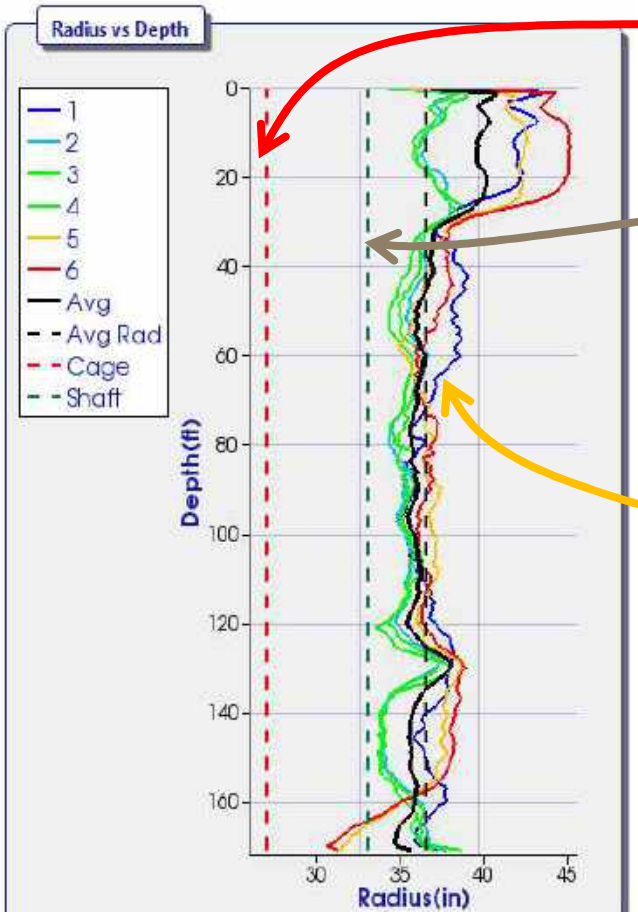

# Konsep

**S**ensor merekam panas hidrasi (suhu) yang dihasilkan oleh beton pada saat proses *curing.*


CAT

# Results




Radius Tulangan

Radius Desain

Bacaan Radius Aktual berdasarkan suhu

# Kelebihan vs Kekurangan

**Interpretasi mudah dipahami**

**Cek kerusakan di beberapa lokasi dan kondisi selimut tiang**

**Tidak dipengaruhi konsistensi tanah sekitar**

**Hanya bisa dilakukan pada tiang *cast in-situ***

**Pengujian hanya bisa dilakukan pada saat proses curing terjadi**

**Pelaksanaan tes memakan waktu cukup lama**


"I keep six honest serving men (they taught me all i knew);
Theirs names are What and Why and When And How And Where and Who."

– Rudyard Kipling

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