


Application Of Geophysical Exploration Methods - Malaysian Experience

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Seminar on Geophysical Exploration Methods for Site Investigation, PWTC, KL JULY 20th 2010

Outline of Presentation

- Introduction of Seismic NDTs
- Surface Wave NDTs
  - SASW Method
  - CSW Method
  - MASW Method
- Application: Case Study & New Advancement

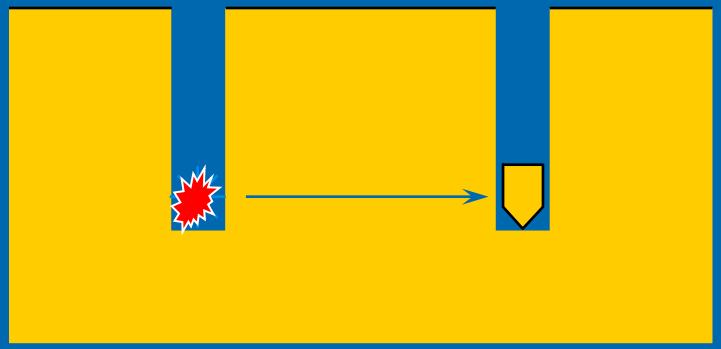
Geophysical Exploration Methods & Application

- Electric Methods (resistivity of ground)
- Seismic Methods (elastic wave propagation)
- Electromagnetic Methods
- Ground Penetrating Radar
- Gravity Methods ?

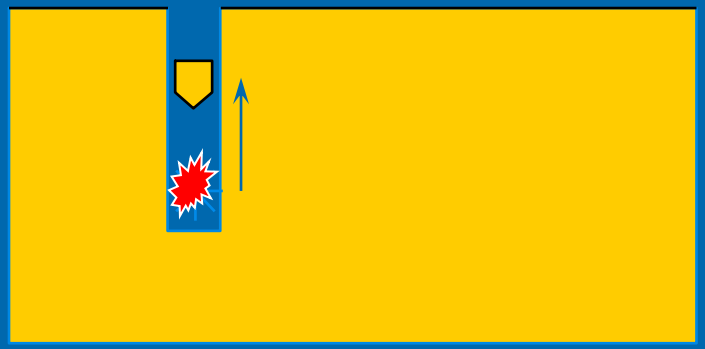
- Can be either instusive or non-intrusive methods

Invasive (Borehole) Methods

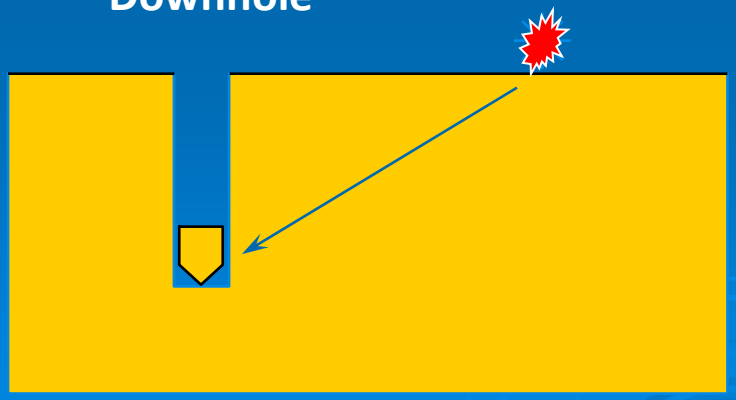
Crosshole (ASTM D4428)



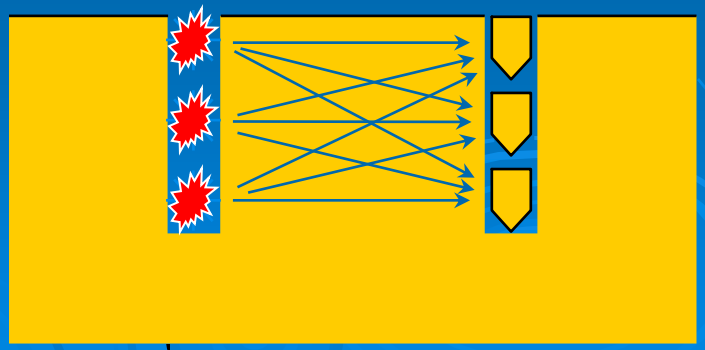
P-S Suspension Logger



Downhole

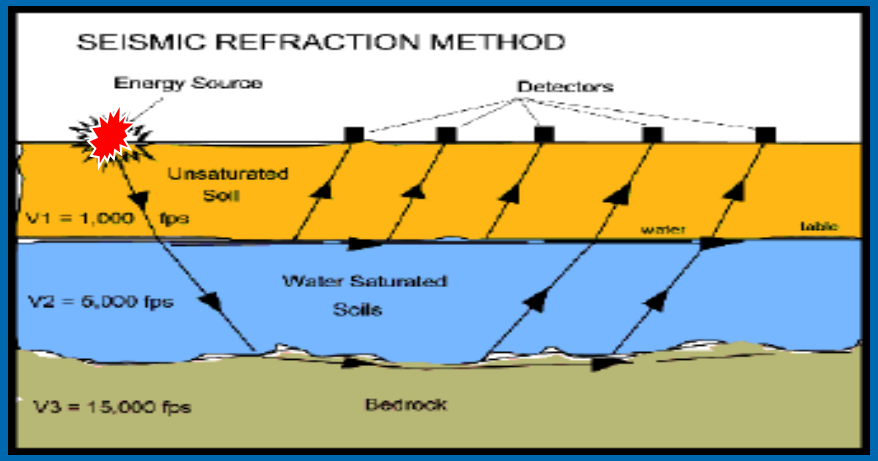


Crosshole Tomography

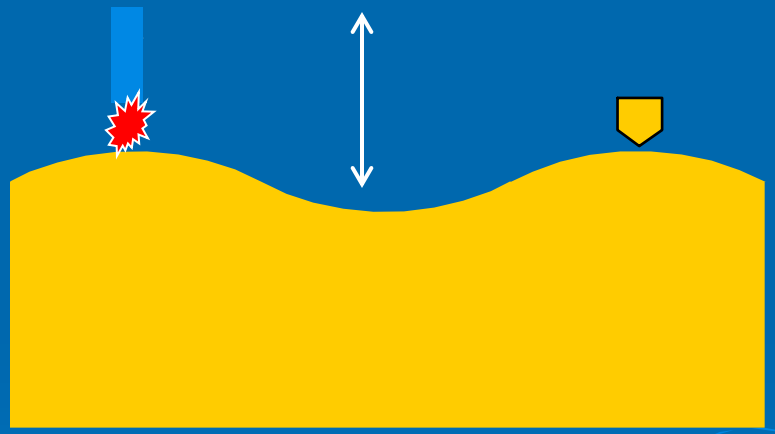


Non-Invasive (Surface) Methods

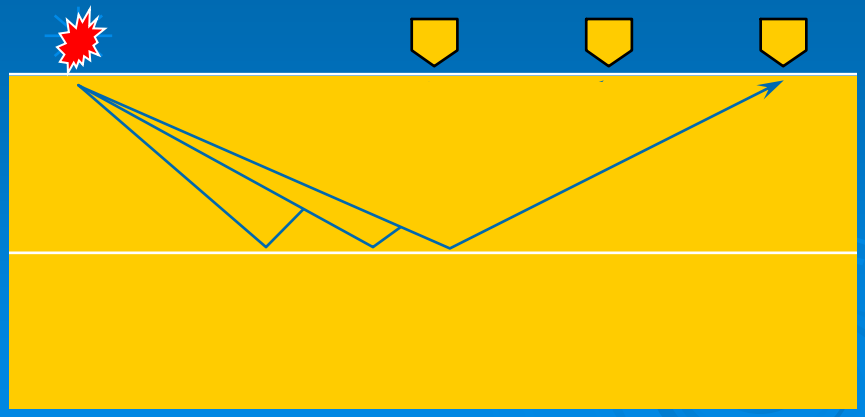
Refraction (ASTM D5777)



Surface Wave



Reflection



Geophysical Exploration - Applications

- To determine the geotechnical engineering properties of earth materials
- For geotechnical forensic investigation works

CASE STUDY

Case 1:

- Investigation of Pile Penetration Length by Parallel Seismic Method

Case 2:

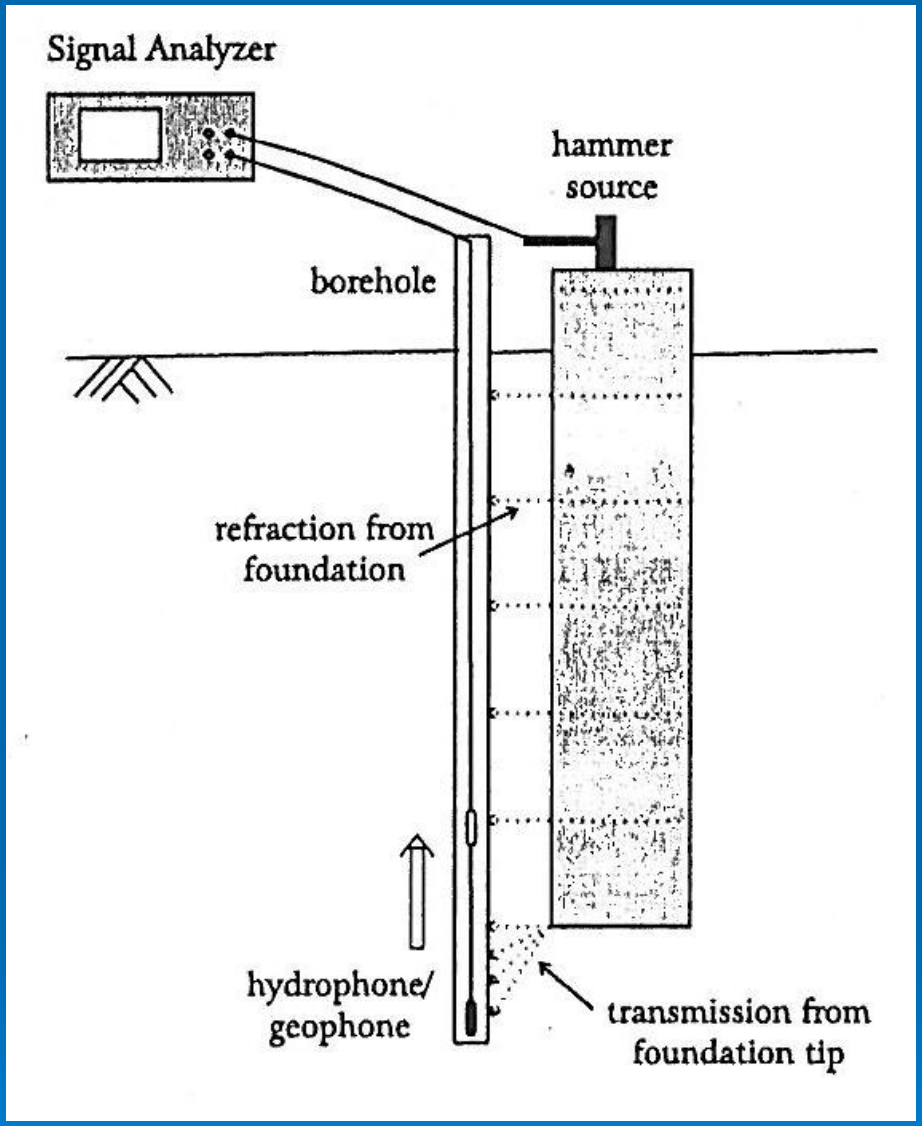
- Investigation of Ground Water Saturation by Resistivity Method

CASE 1: Investigation of Pile Penetration Length by Parallel Seismic Method

SK Danau Perdana ditutup segera

B/Harian 5/5/2005

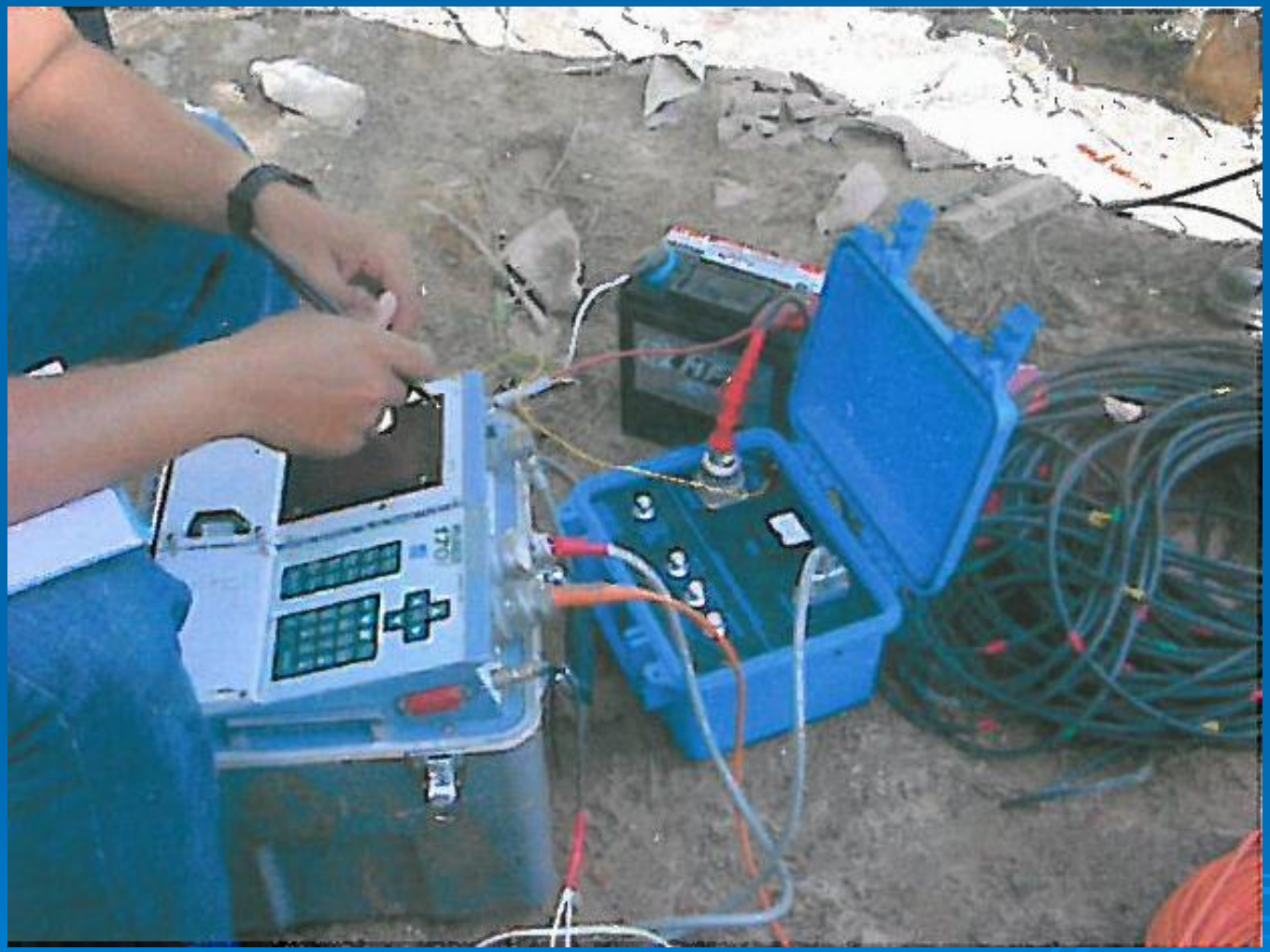
SEKOLAH Kebangsaan Danau Perdana di Sungai Besi ditutup serta-merta selepas mengalami kerosakan struktur yang teruk. Dua blok sekolah itu didapati tidak selamat dan 300 murid serta guru dipindahkan ke sekolah berhampiran.
– Gambar oleh Rosdan Wahid



Parallel Seismic Test

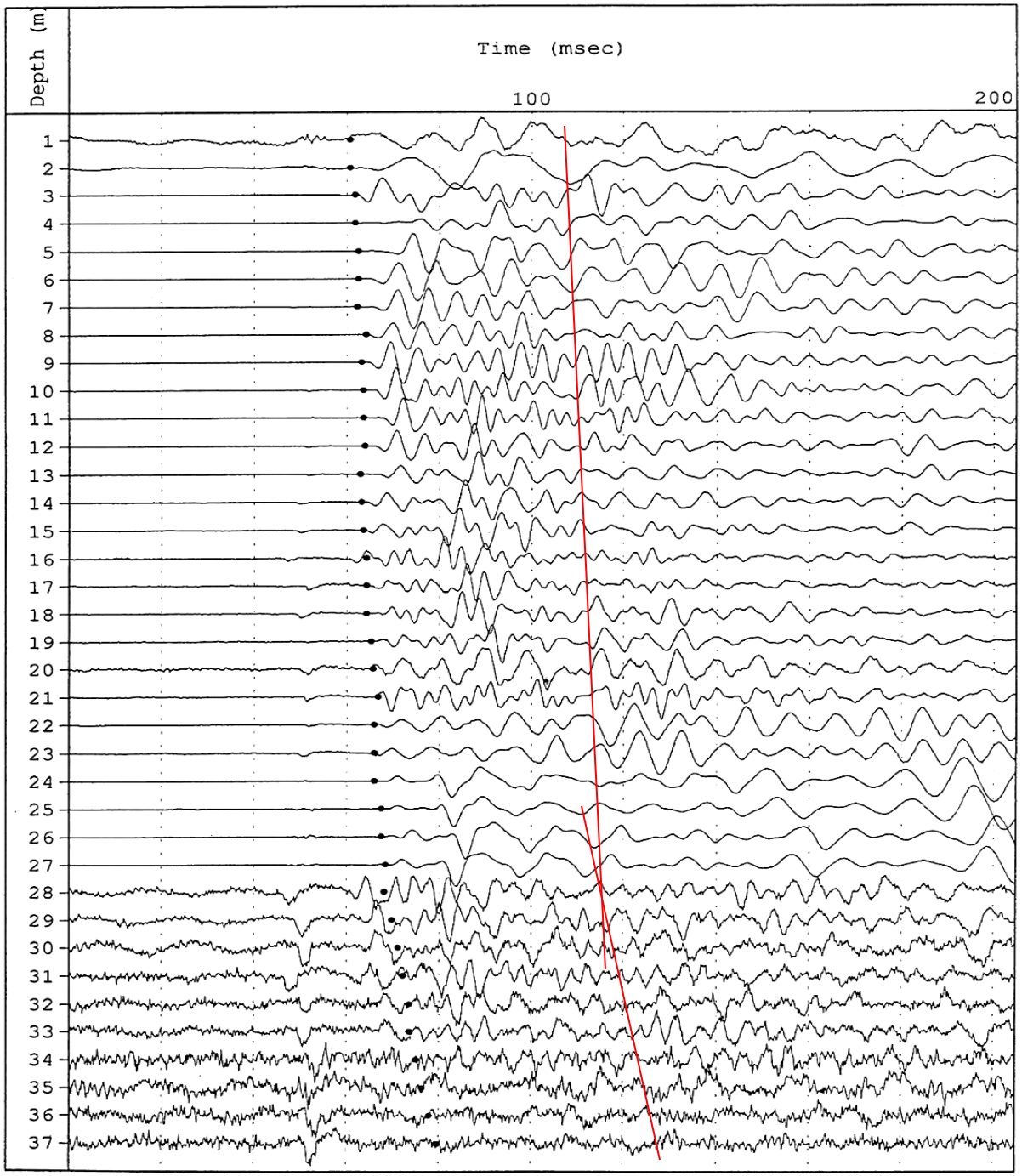
- Testing Layout

Lowering of Hydrophone into PVC Borehole



McSeis 170f 24-Channel Seismograph

Wave Source generated using sledgehammer


Depth (m)
Time (msec)
100
200
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
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34
35
36
37

Waveform

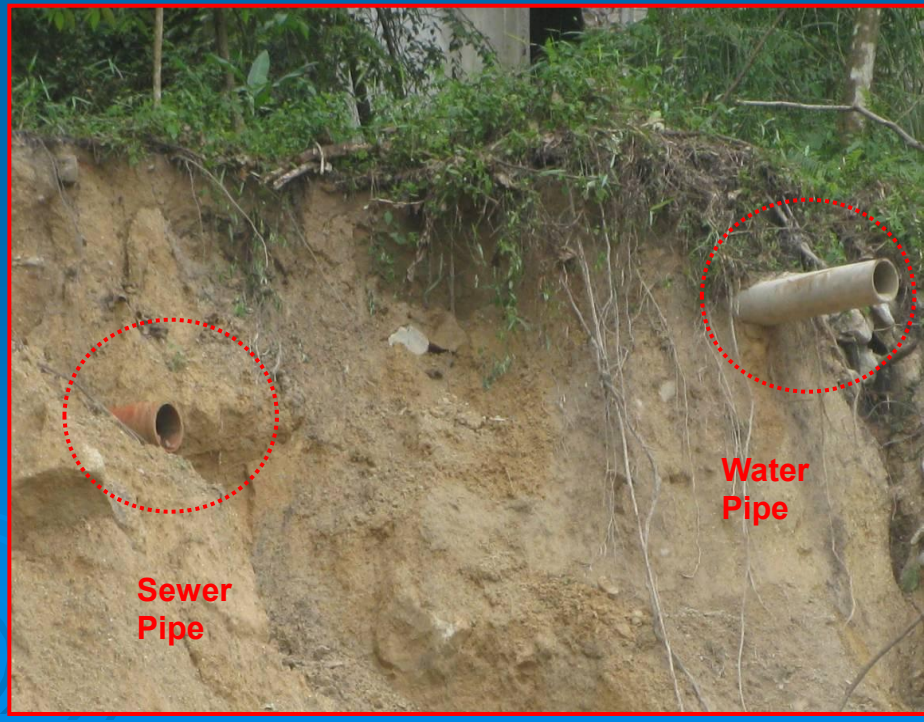
Case 2: Investigation of Ground Water Saturation by Resistivity Method

View of Bukit Antarabangsa Landslide

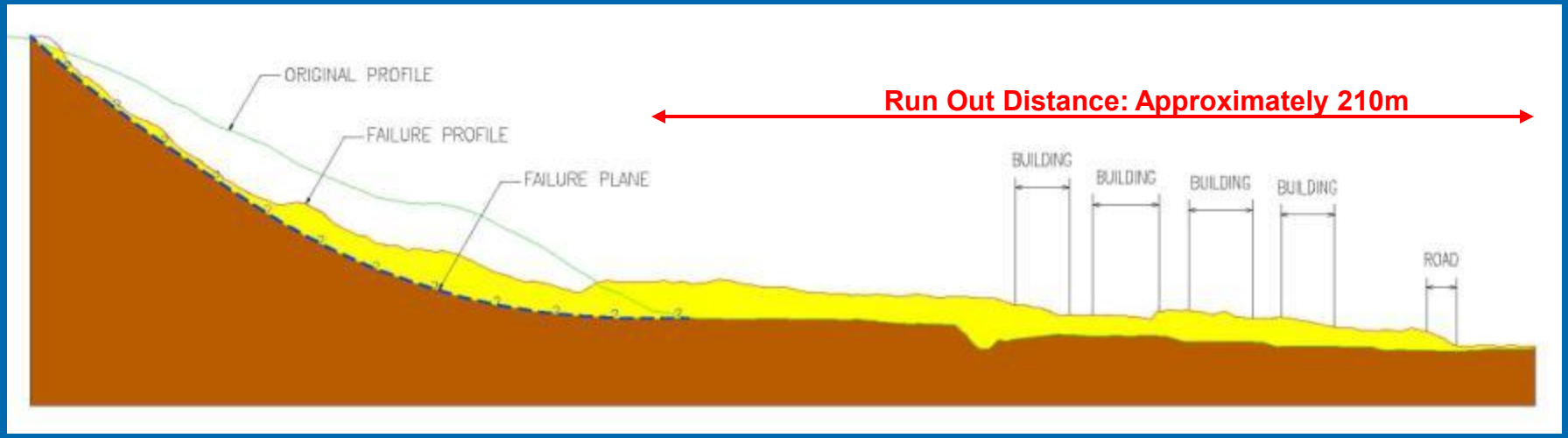
Date: 6th December 2008
Time of Occurrence: Approximately 3.30 a.m.

The Extent of Landslide Destruction:

- 14 bungalow houses destroyed
- 5 fatalities
- 14 injuries
- Restricted Road Access for 5000 residents' (Jalan Bukit Antarabangsa - blocked by failure debris)


Sewer
Pipe
Water
Pipe

Landslide Cross-Section

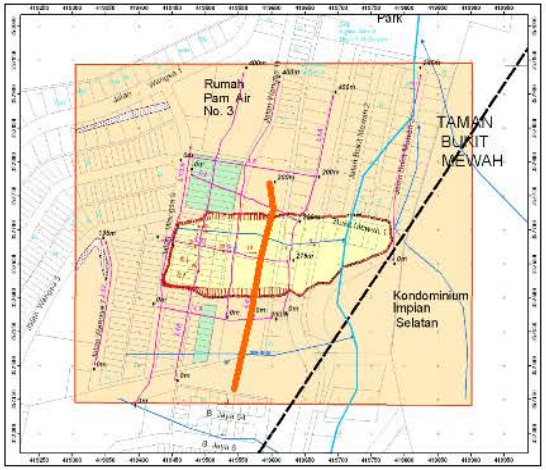


Landslide Measured:

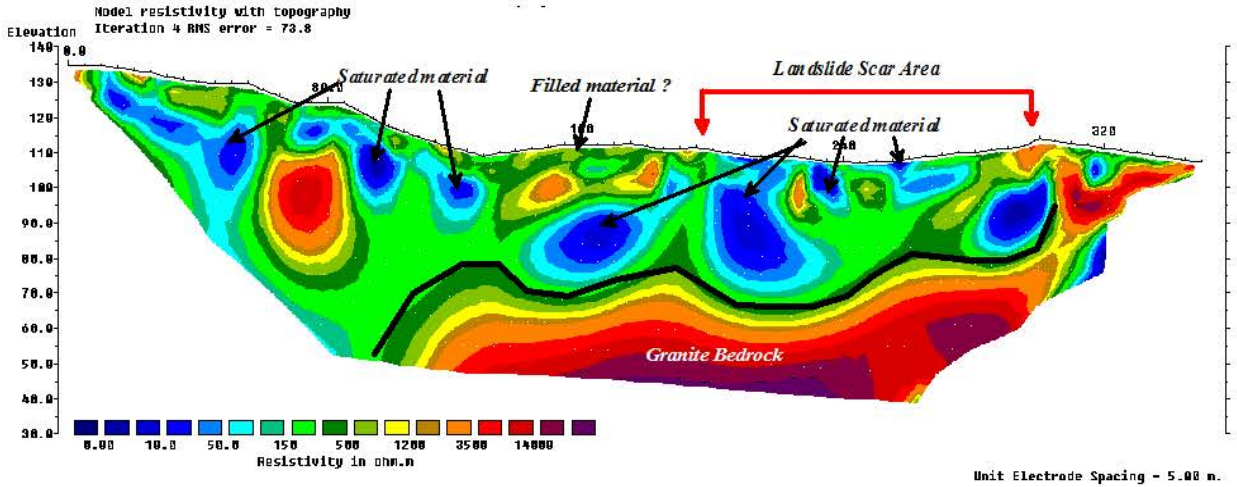
- 109m (Width at Crest), 120m (Length), 15m (Depth)
- Angle of scarp (crown)=45 to 50 degrees
- 101,500 cubic meters of earth translated

Plan View of the Geophysical Survey Lines

Location of Line 4



Resistivity Profile Line 4



RESISTIVITY SURVEY AT BUKIT ANTARABANGSA LANDSLIDE

Survey date: 20 December,2008
Surveyed by: Rosli
Checked by: Azhari

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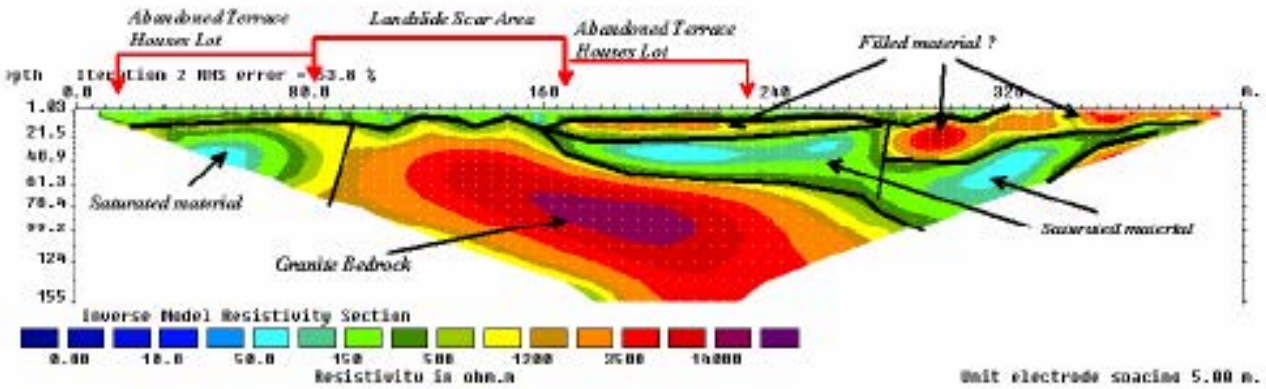
RESISTIVITY PROFILE LINE 4

Resistivity Profile Line 10



Location of Line 10

RESISTIVITY SURVEY AT BUKIT ANTARABANGSA LANDSLIDE

Survey date: 22 December, 2008
Surveyed by: Rosli
Checked by: Azhari

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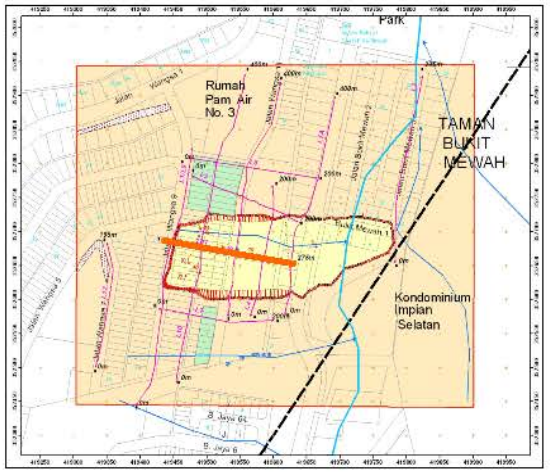
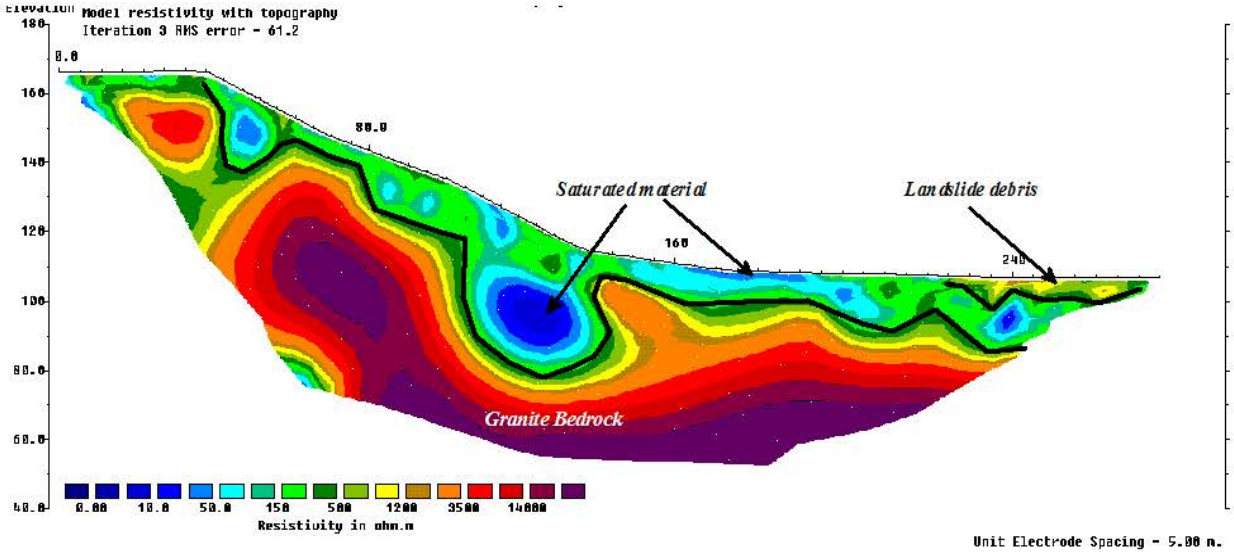
RESISTIVITY PROFILE LINE 10

Location of Line 11



RESISTIVITY SURVEY AT BUKIT ANTARABANGSA LANDSLIDE

Resistivity Profile Line 11



Survey date: 21 December,2008
Surveyed by: Rosli
Checked by: Azhari

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RESISTIVITY PROFILE LINE 11

NEW ADVANCEMENT

SEISMIC METHODS

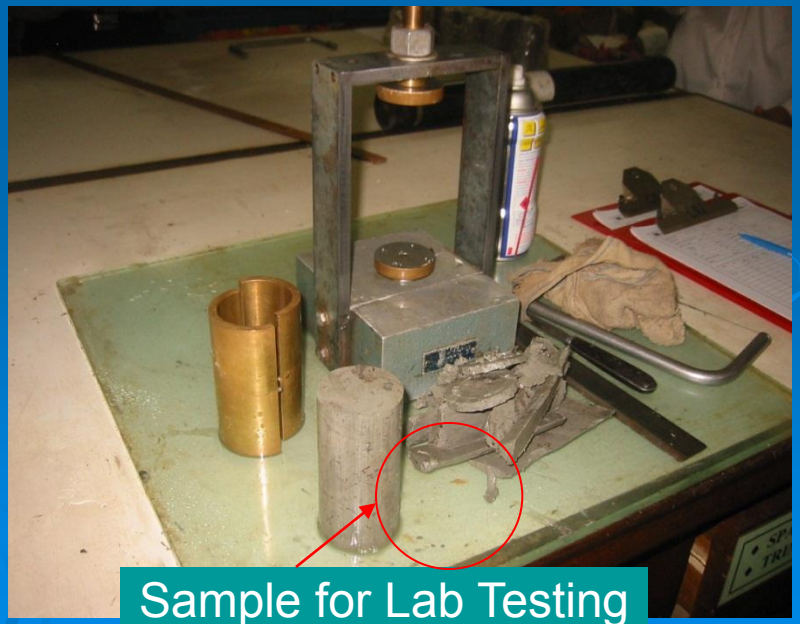
Prediction of Long-Term Settlement of Soft Clay using Shear Wave Velocity and Damping Characteristics

Settlement Problems In Soft Clay

- Major limitations in traditional calculation methods
  - The clay-water system is not truly homegeneous
  - The flow of water is not 1-D
  - The soil grains are compressible
  - Saturation is not always complete
  - Viscoelastic property of soil should be considered

- Limitations in Lab and In Situ Tests
  - Drilling
  - In Situ Tests
  - Sampling
- Intrusive in nature
- Time-consuming

Wash boring

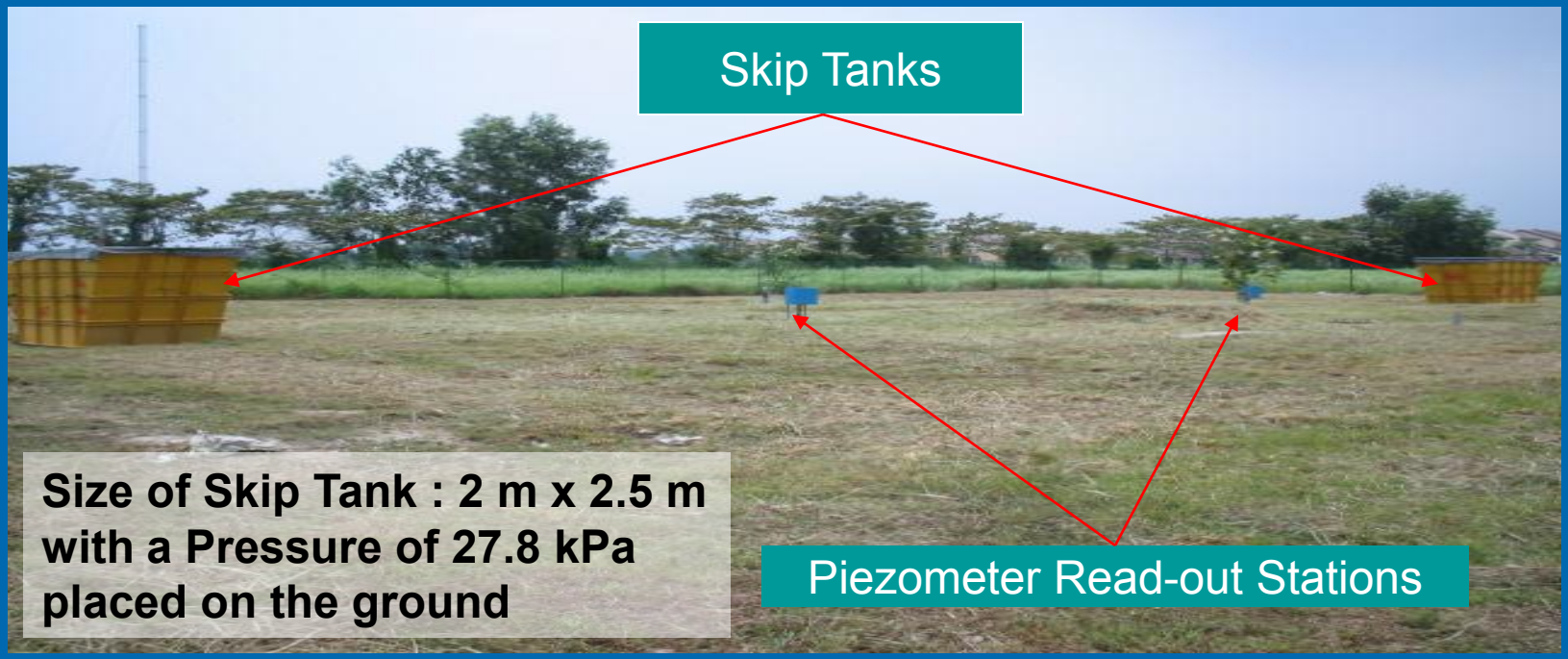


Sample for Lab Testing

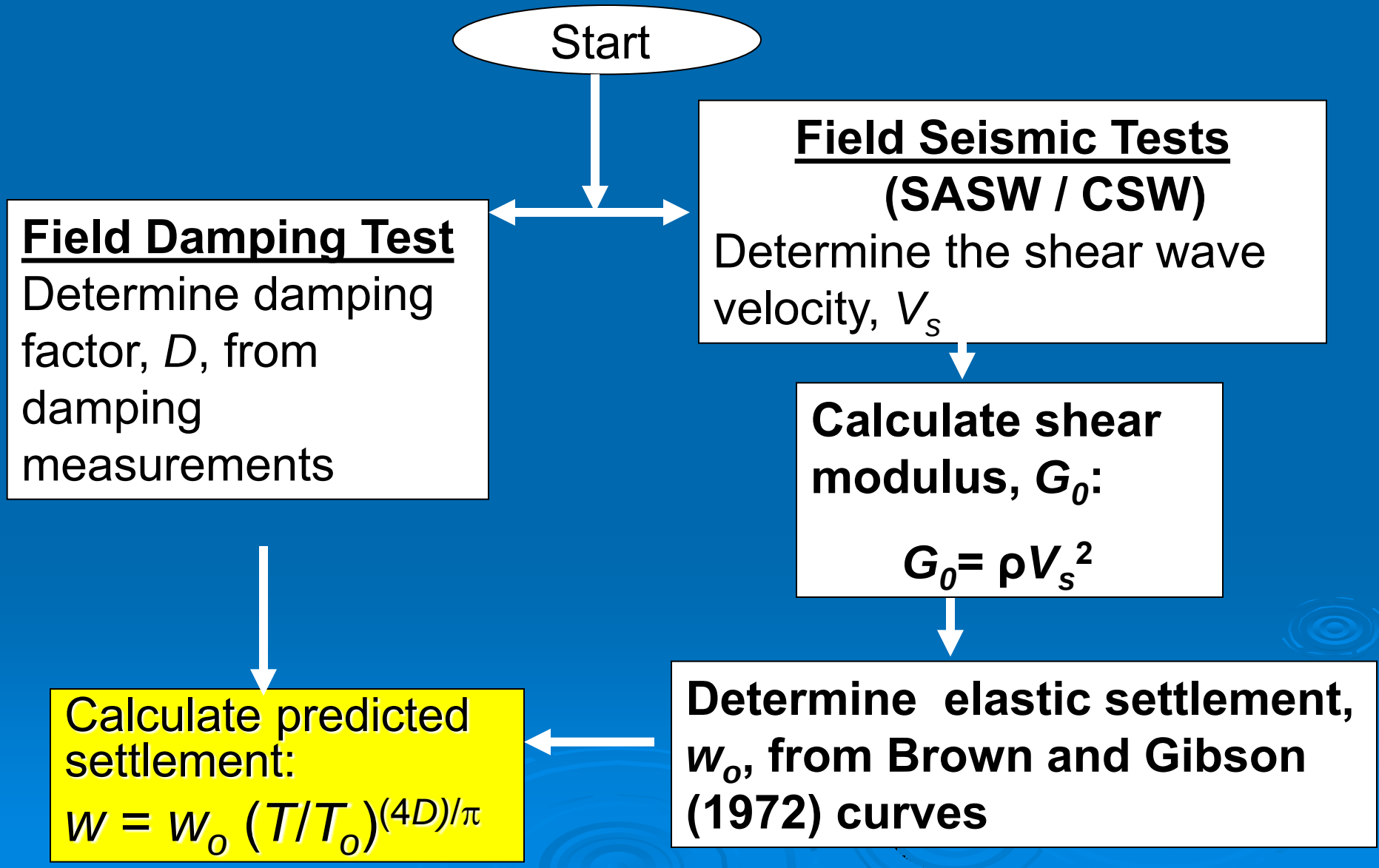
Alternative methods of in situ testing and calculation of settlement prediction

- Fast
- Reliable
- More representative of soil tested
- Non-intrusive

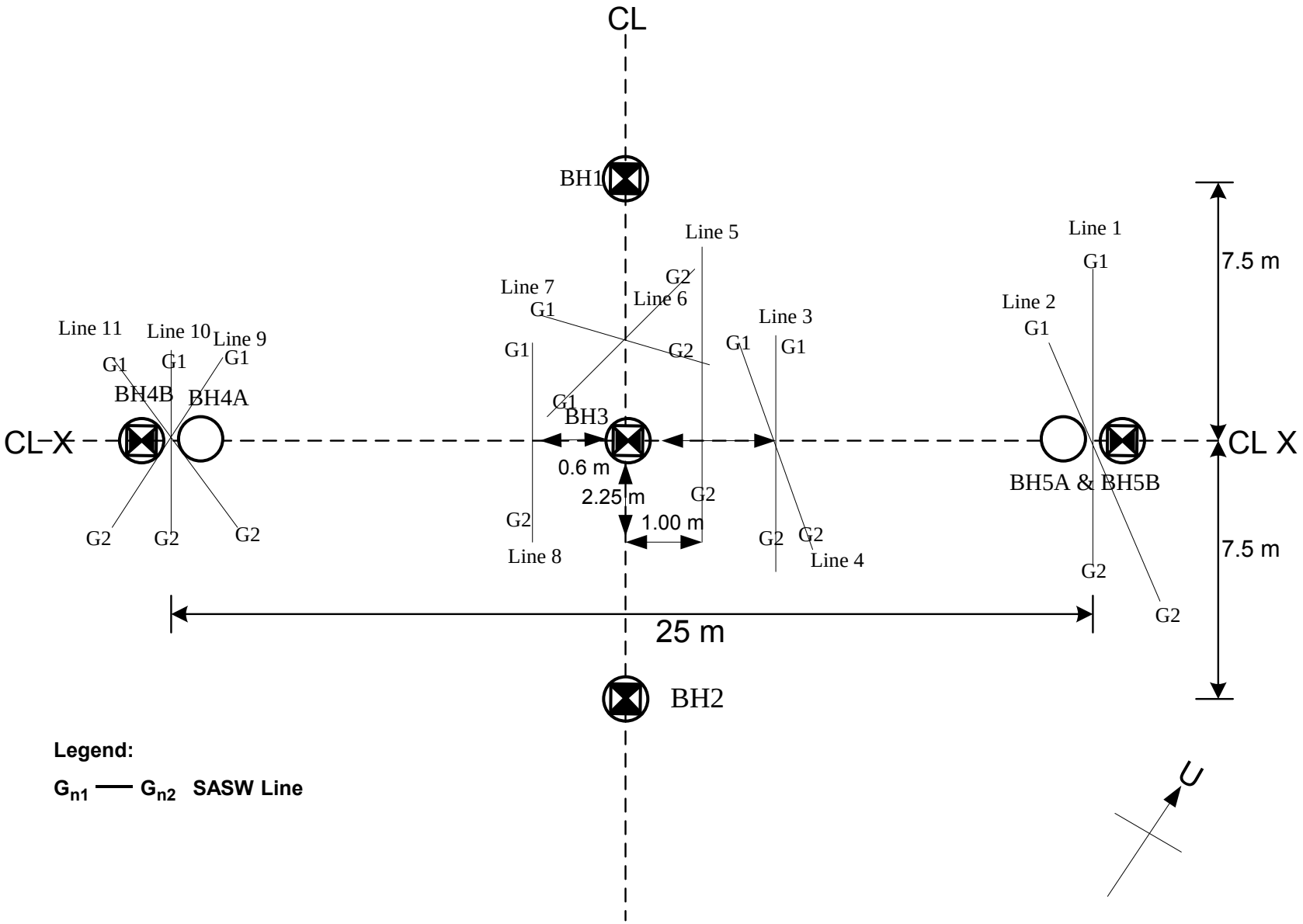
Layout of Skip Tank and Instrumentations Installed



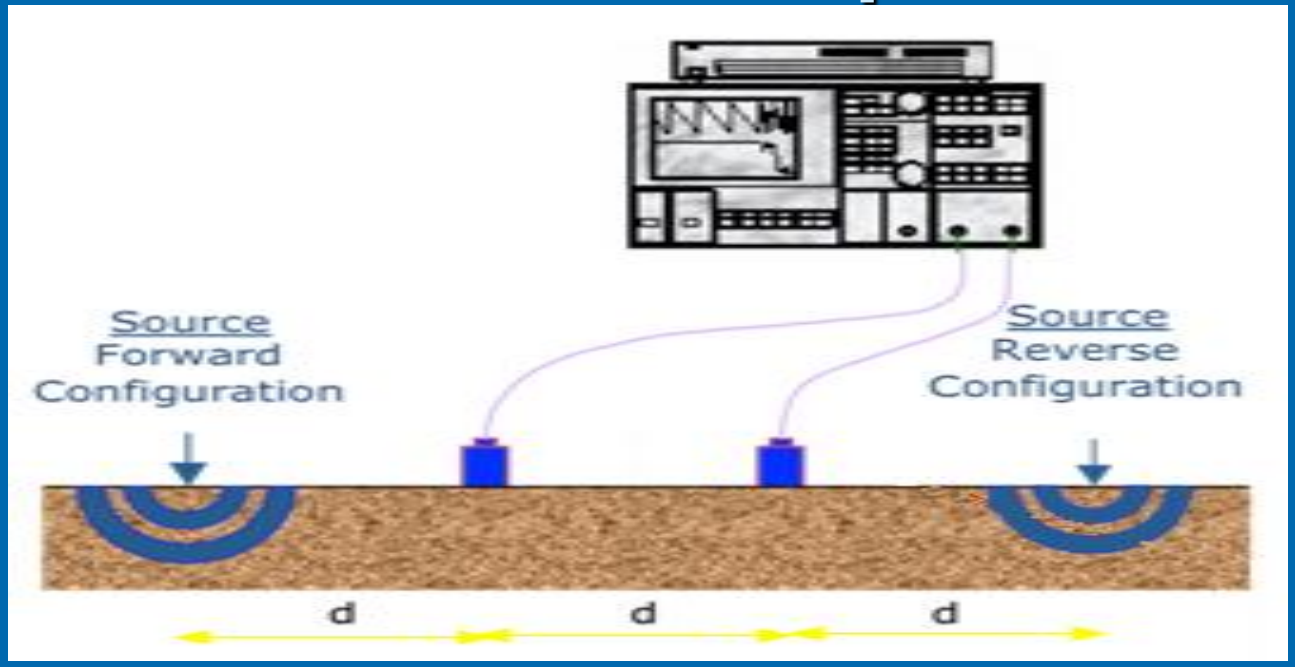
Flowchart of Settlement Prediction



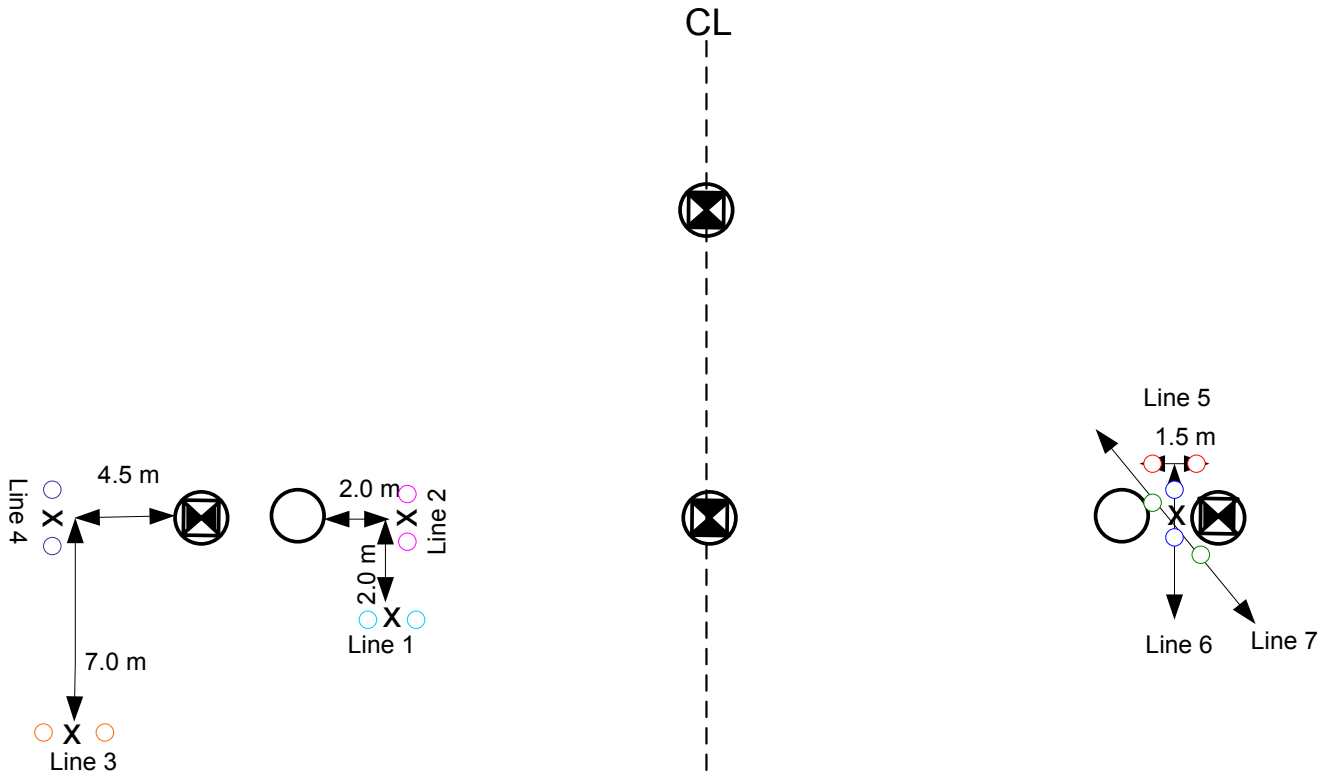
Layout of SASW Test Locations



SASW Setup


Source
Forward
Configuration
Source
Reverse
Configuration
d
d
d

Layout of CSW Test Locations



Layout of Continuous Surface Wave

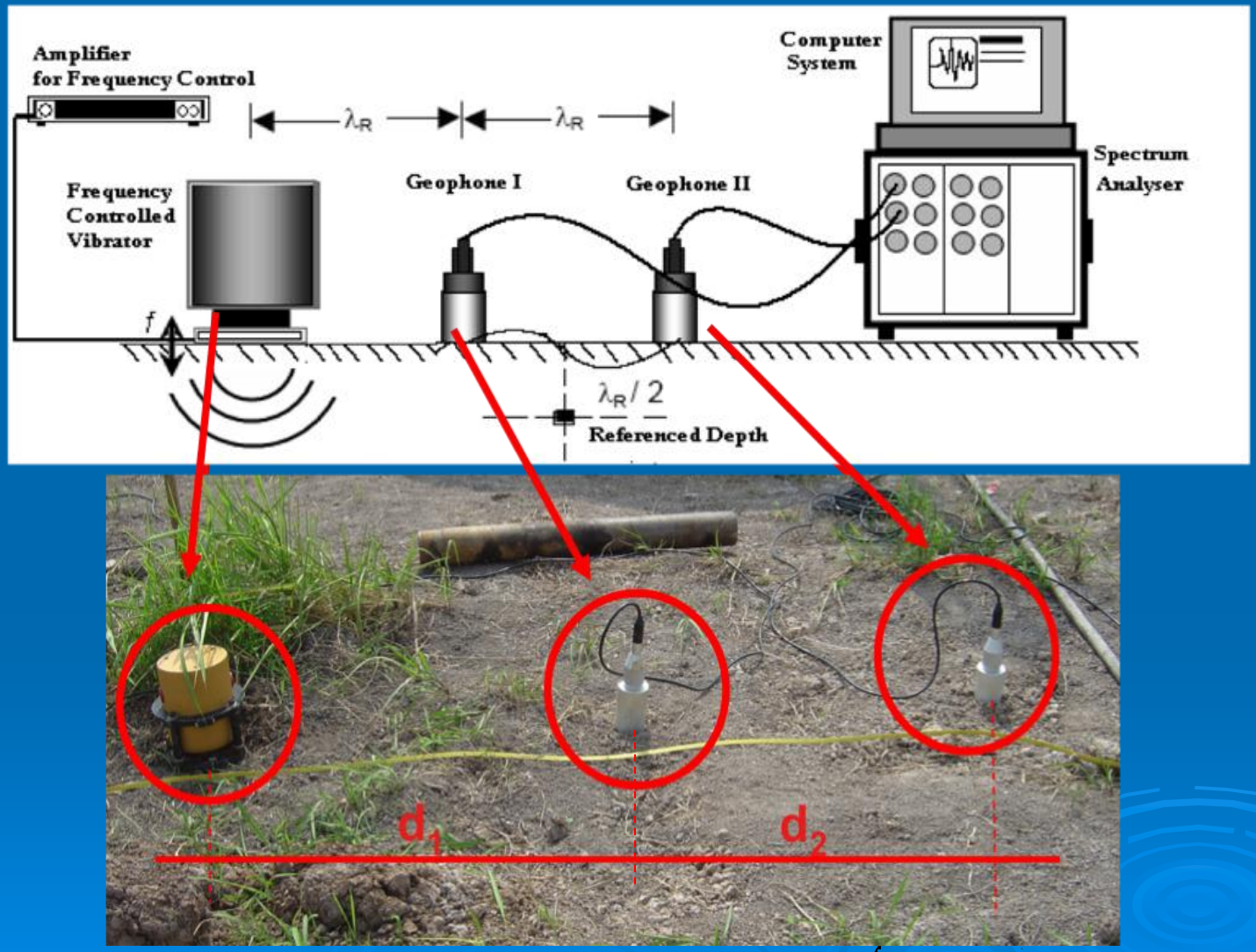
Legend:

X- mid-point between geophones

○ - geophone/transducer

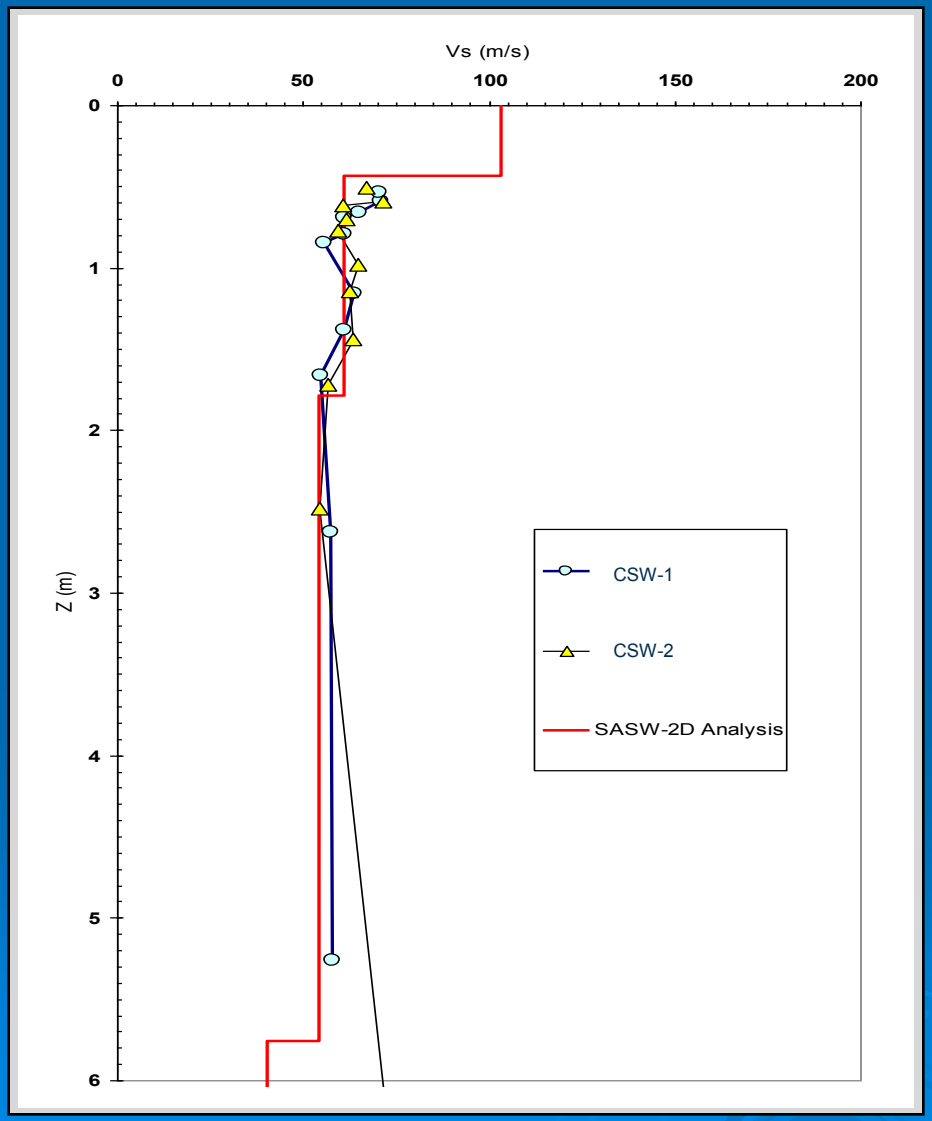
○ X ○ - CSW Line

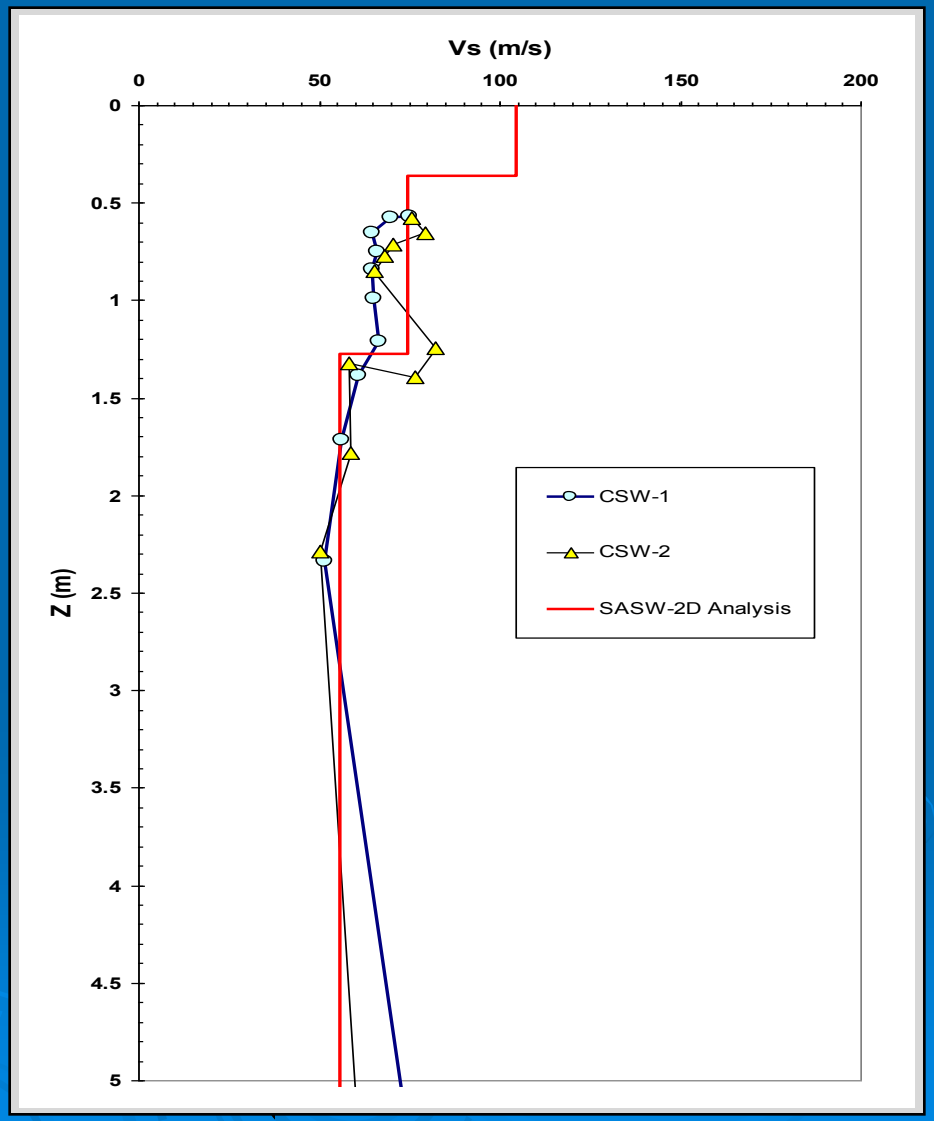
CSW Setup


Amplifier
for Frequency Control
λ_R
λ_R
Computer
System
Spectrum
Analyser
Frequency
Controlled
Vibrator
Geophone I
Geophone II
f
$\lambda_R / 2$
Referenced Depth
d_1
d_2

RESULTS

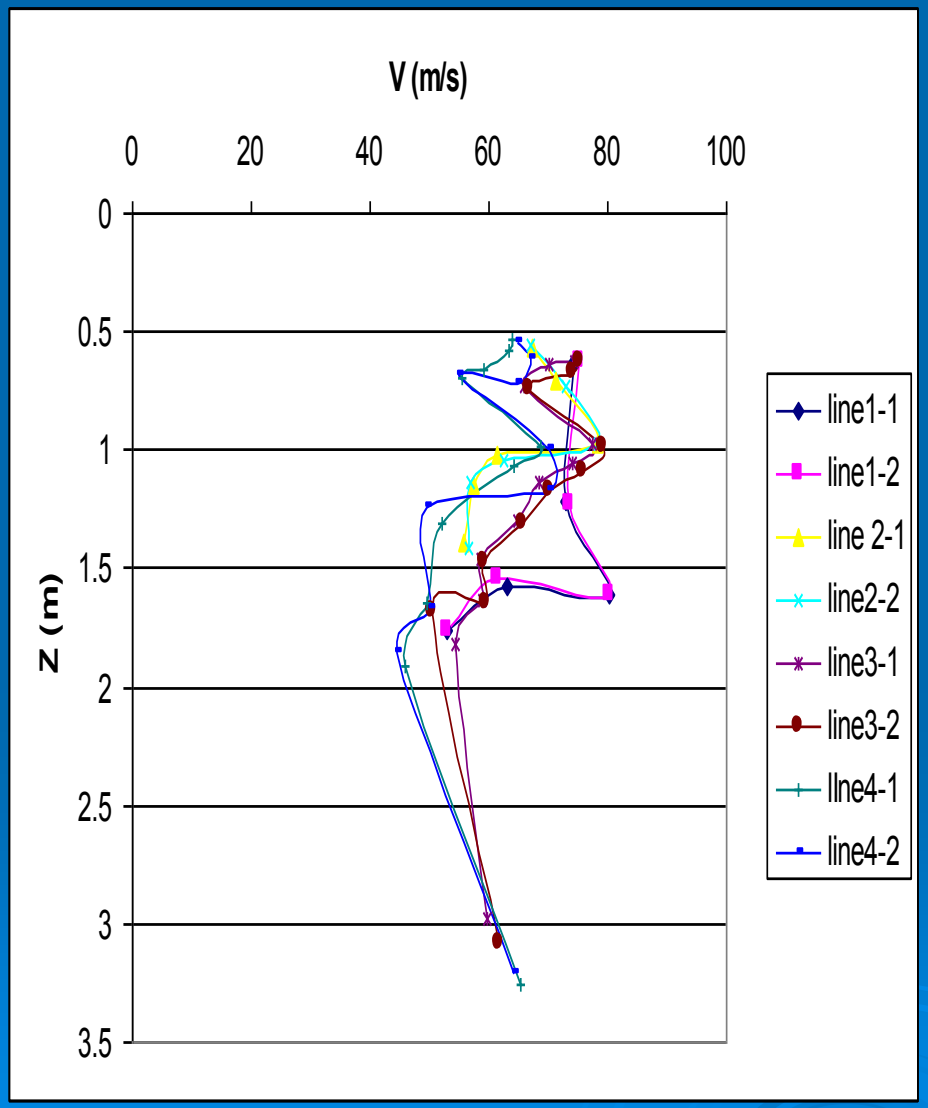
Comparison of Shear Wave Velocity of SASW Test and CSW Test

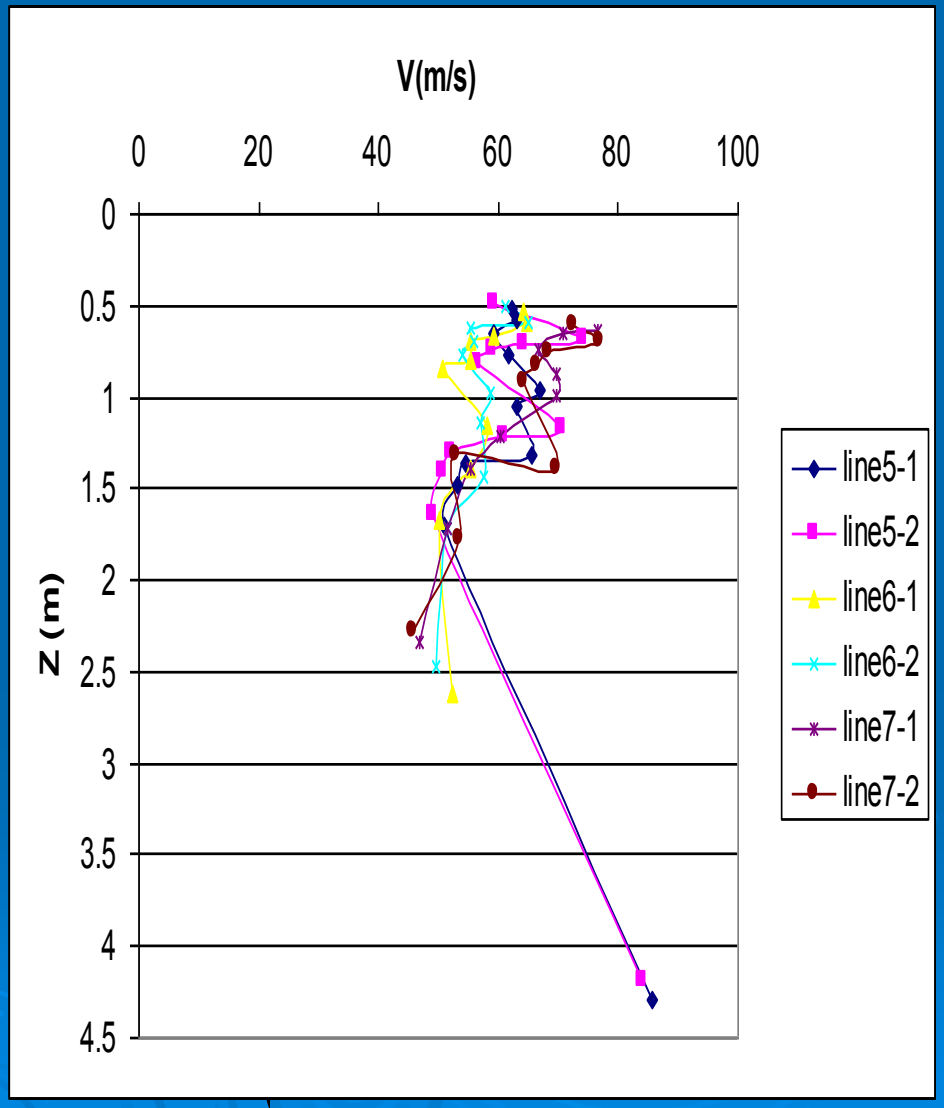




Average SASW V_s = 53.18 m/s

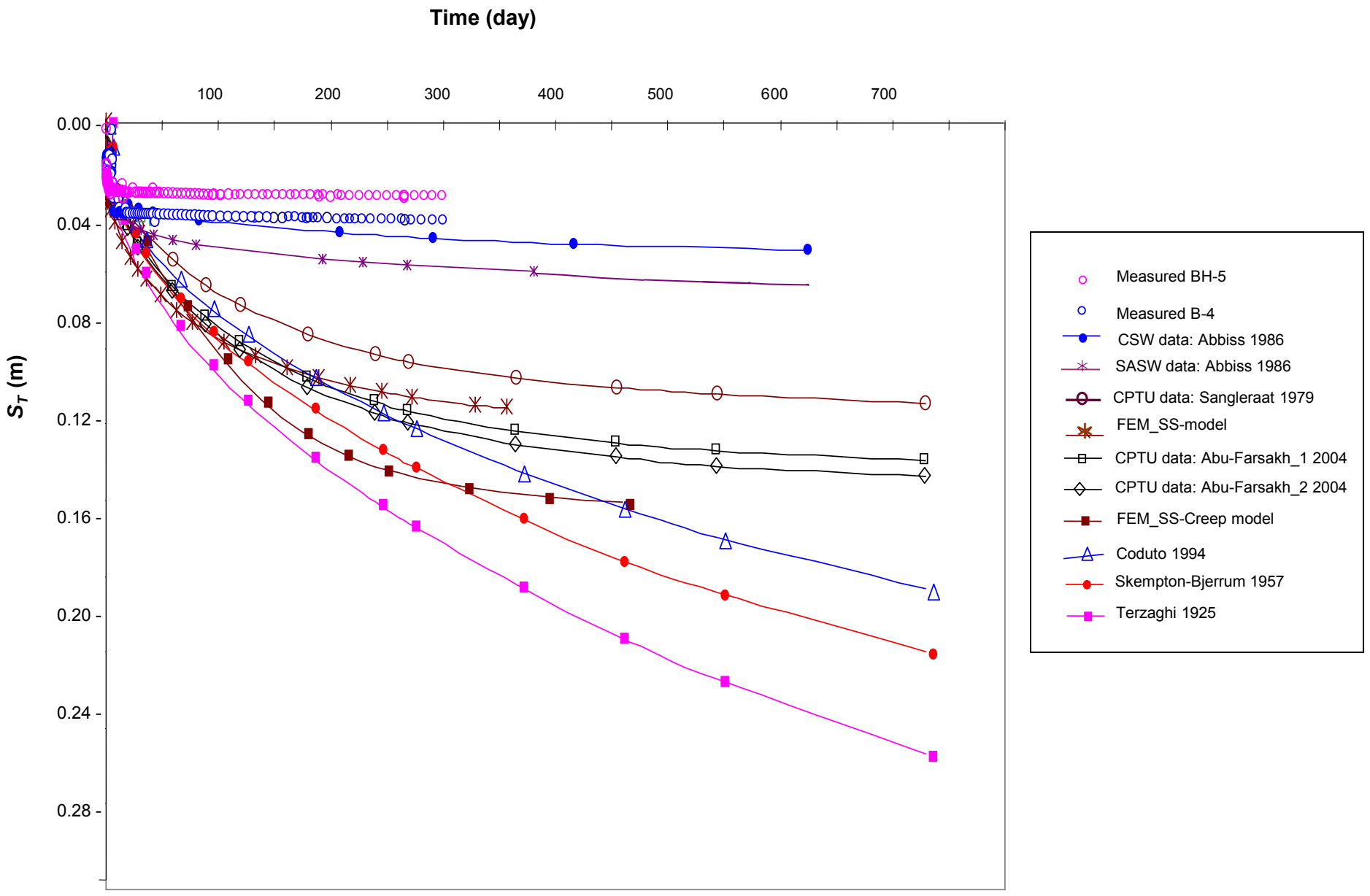
Typical V_s versus Depth from CSW Tests for Lines L1-4 and L5-7





Average CSW V_s = 56.13 m/s

Comparison with Other Methods



CONCLUSIONS

- Both CSW and SASW tests capable of providing better long-term settlement predictions of soft clay compared to conventional methods
- Geophysical Exploration Methods more reliable and can be use to substantiate Borelogs
- Proven to be faster in aquiring data geotechnical properties of soil & much cheaper compared to conventional methods
- gives efficient non-destructive method for in situ determination of shear stiffness
- Non-invasive and non-destructive
- More representative of the site


Thank You