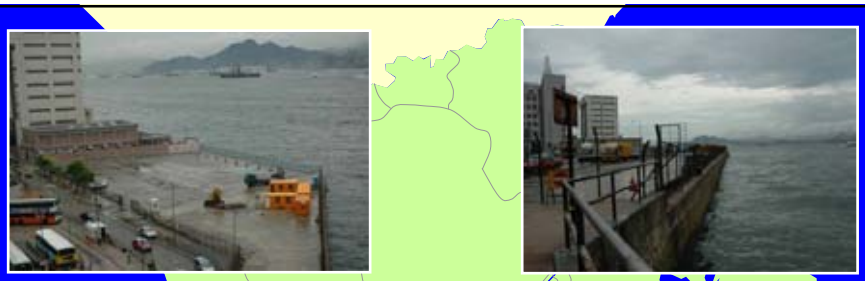
Design of Temporary Excavation and Lateral Support System for the DSD Sheung Wan Stormwater Pumping Station

By Eric Li - GCG (Asia)

Presented to the HKIE Geotechnical Division
18th June 2008



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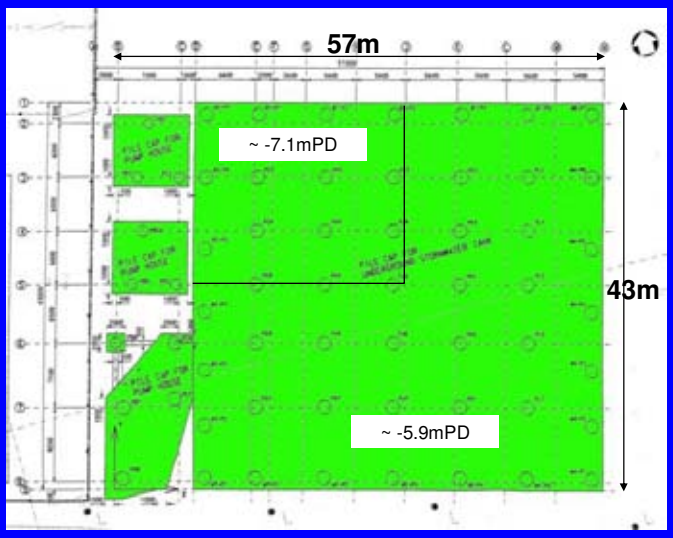
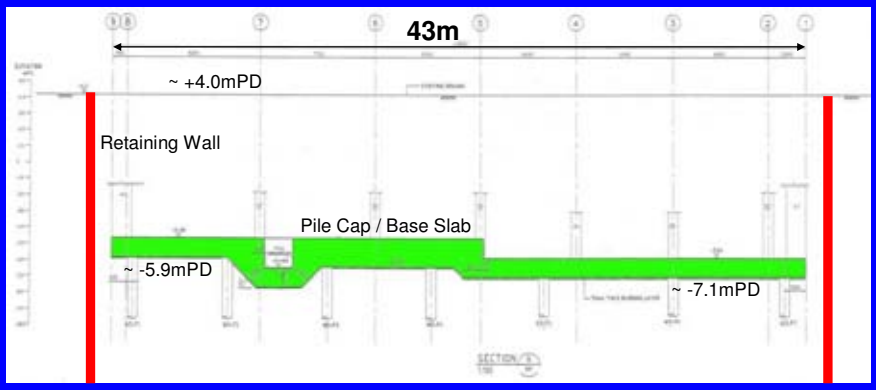
HKIE Technical Talk – ELS Design for SWSPS – 18 June 2008

Project Set Up

- DSD Contract DC/2006/10
- Contract Sum : HK$ 78 million (approx)
- Designer : Drainage Services Department
  (with GEO as in-house geotechnical consultant)
- Site Supervision : DSD Drainage Project Division
  (with the engagement of an IGE)
- Contractor : China National Chemical Engineering Group
- ELS Designer : Geotechnical Consultant Group (Asia) Ltd.



Pile Cap Layout Plan



Typical North-South Section

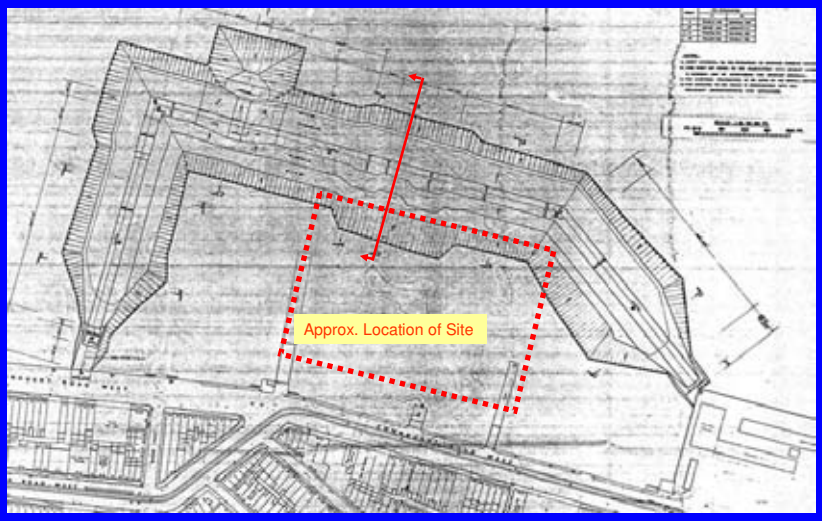
Selection of Retaining Wall Type

Wall Types Considered:

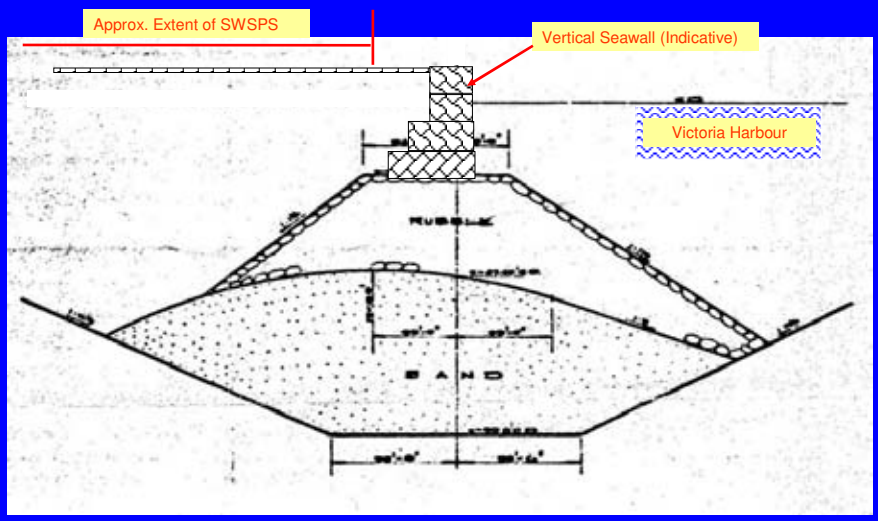
- Diaphragm Wall
- Bored Pile Wall
- Pipe Pile Wall
- Sheet Pile Wall
- No wall (open cut)

Design Objectives:

- Approximate max. 10m deep excavation
- Effective control of settlement due to excavation and groundwater drawdown



Reclamation and Seawall Dredging Plan

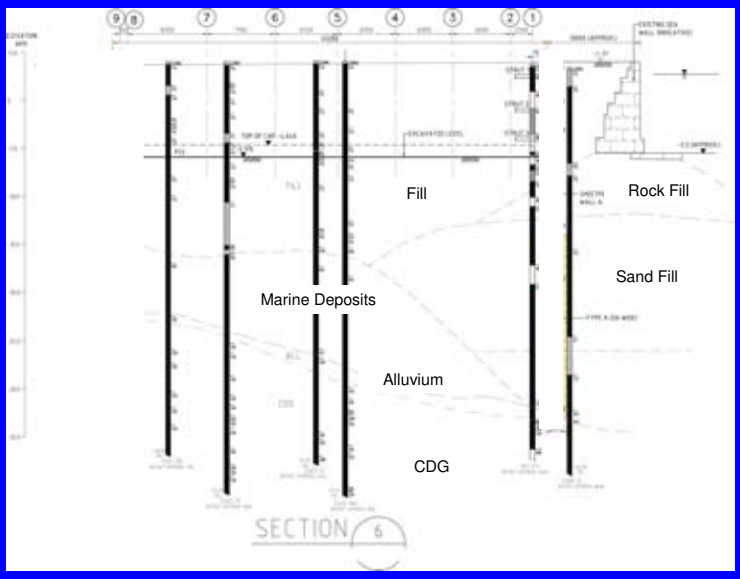


Typical Cross Section

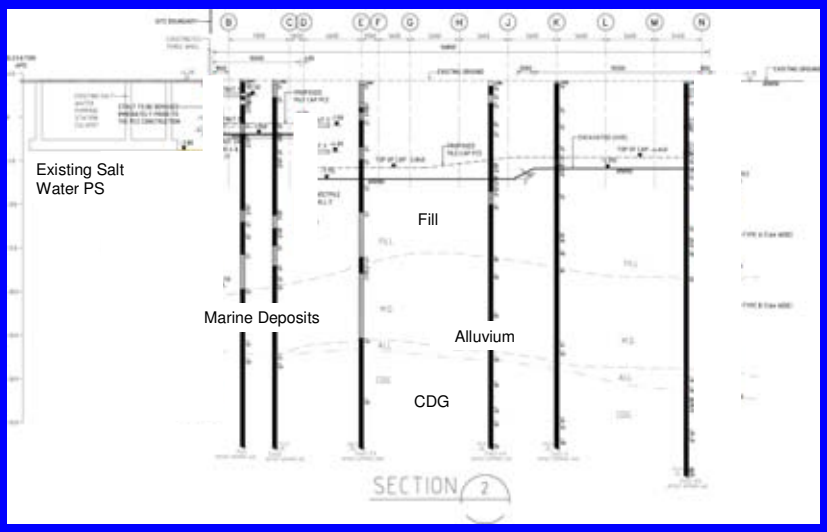
Pre-Contract Ground investigation

- 2 series in 2002 & 2006 (32 holes)
- Common sampling, field and laboratory tests
- In situ vane & pressuremeter tests

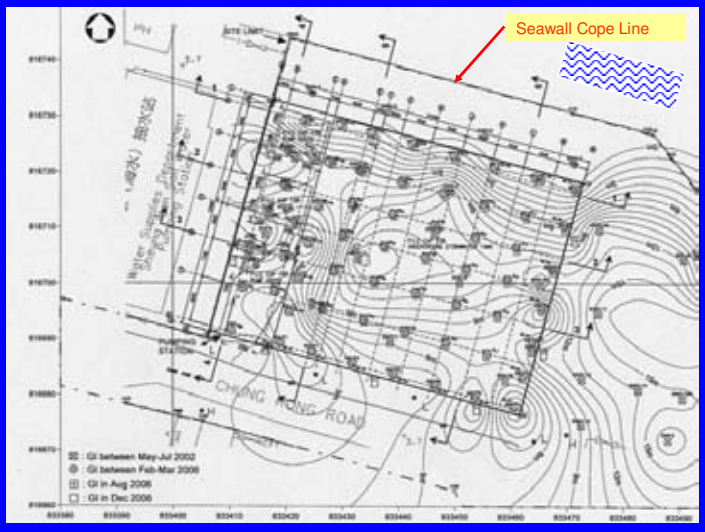
Pre-Contract Borehole Location Plan



North-South Geological Section



East-West Geological Section
(away from Seawall)

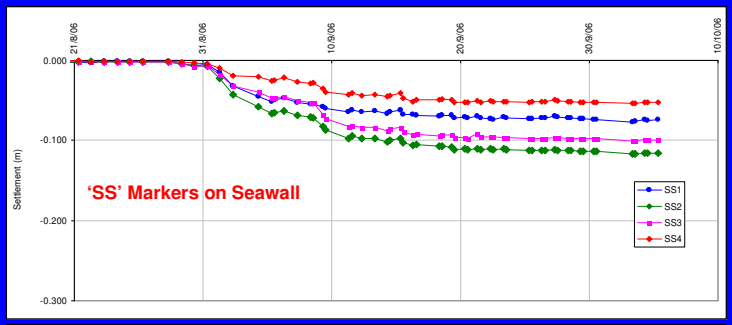


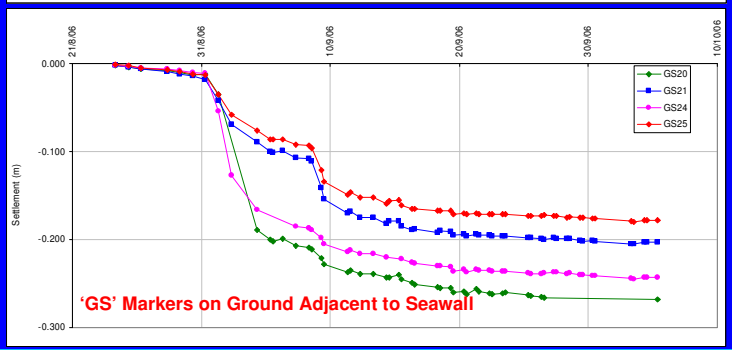
Isopach of Soft Marine Clays

Small sink hole at sea wall

5m^3 sink hole

15m^3 sink hole



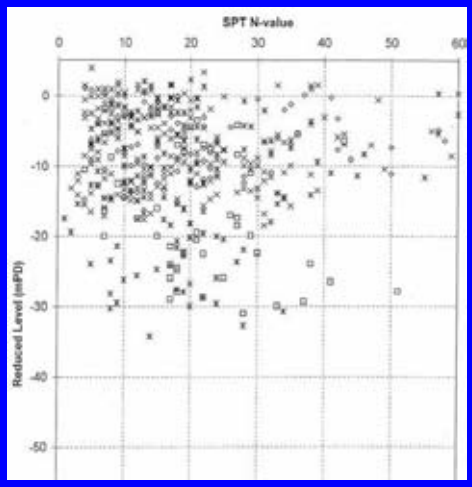


Design Considerations

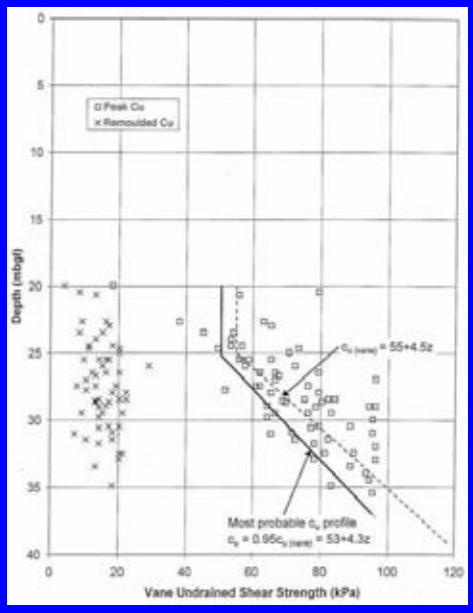
- Reclamation Site
- Sensitive Structures nearby, i.e. WSD Pumping Station
- High water table, i.e. 1.2m below existing ground level (+3.0mPD)
- Presence of thick layer of variable FILL
  & soft MARINE DEPOSITS

Design Methodology

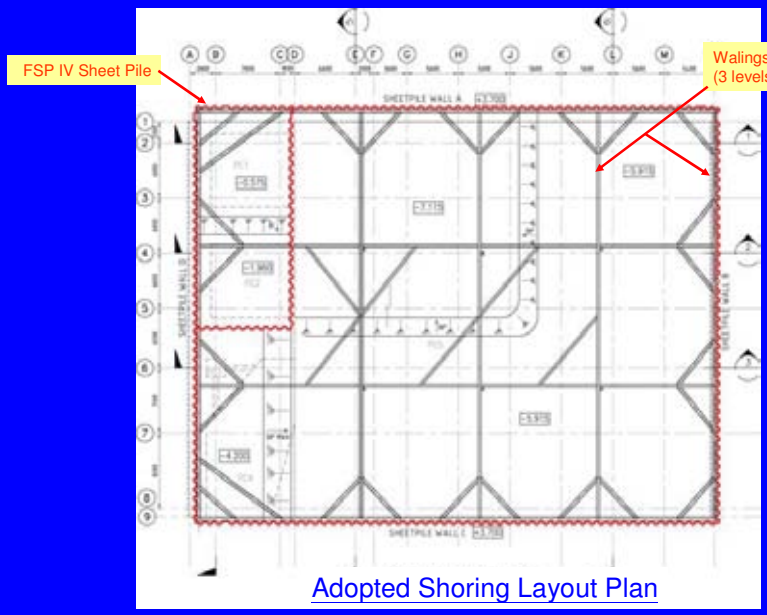
- Drained and Undrained Conditions
- Lateral Stability
- Global Slope Stability
- Base Stability
- Hydraulic Stability
- Dewatering
- Ground Deformation / Settlement
- Structural Capacities



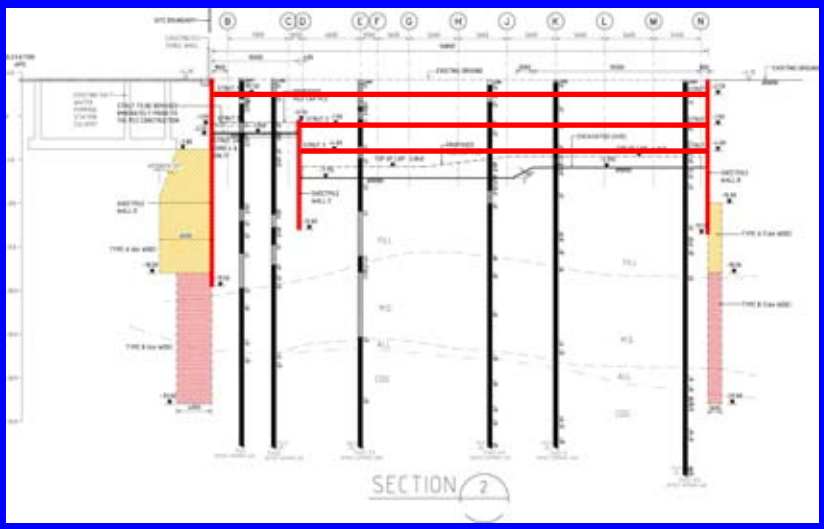
Plot of SPT-N against Elevation



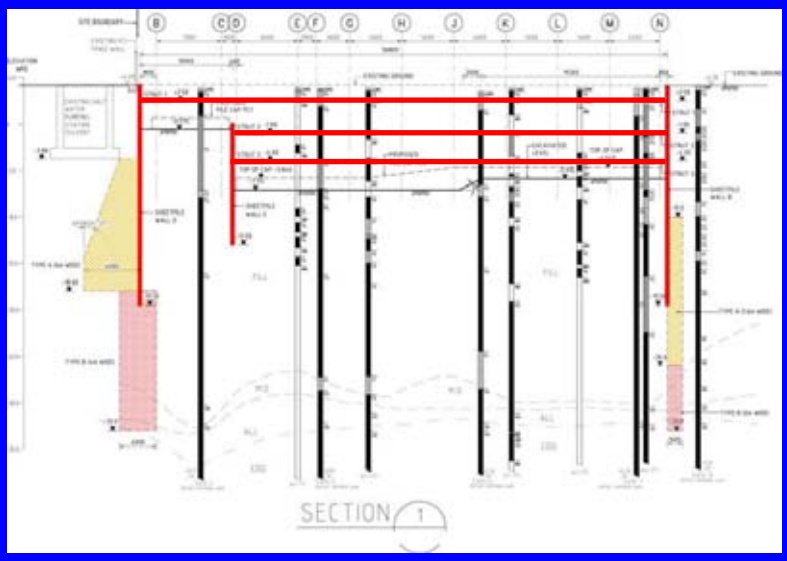
Plot of Undrained Shear Strength (Cu) against Elevation



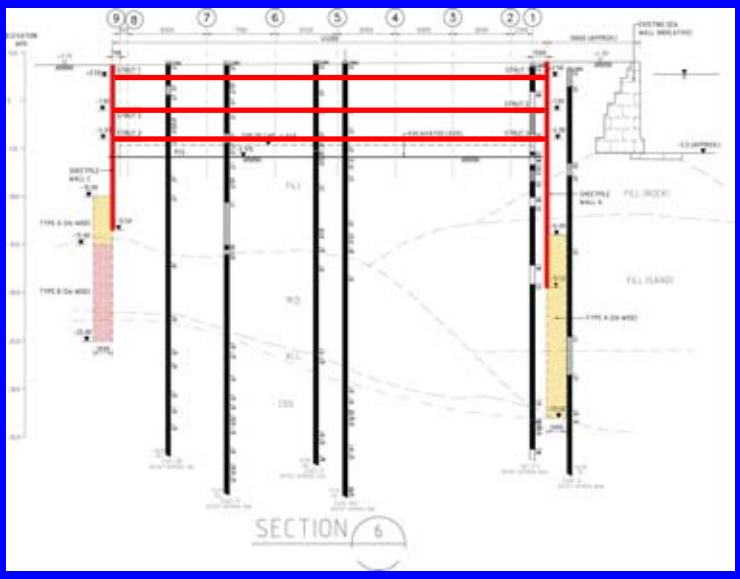
Adopted Shoring Layout Plan



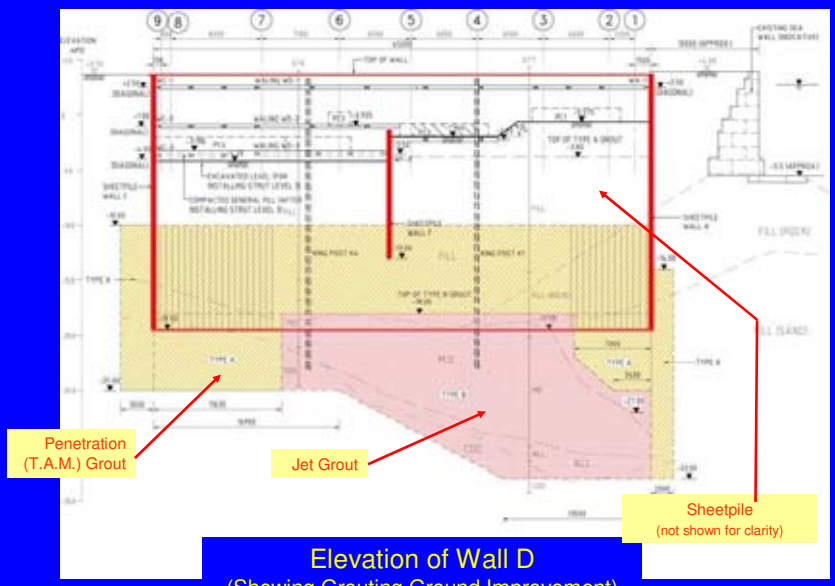
Longitudinal Cross Section further from Seawall



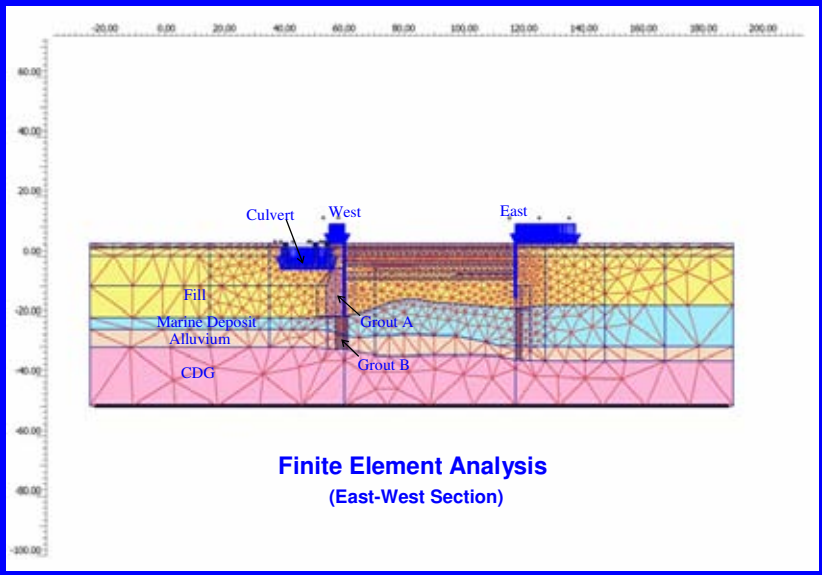
Longitudinal Cross Section nearest Seawall



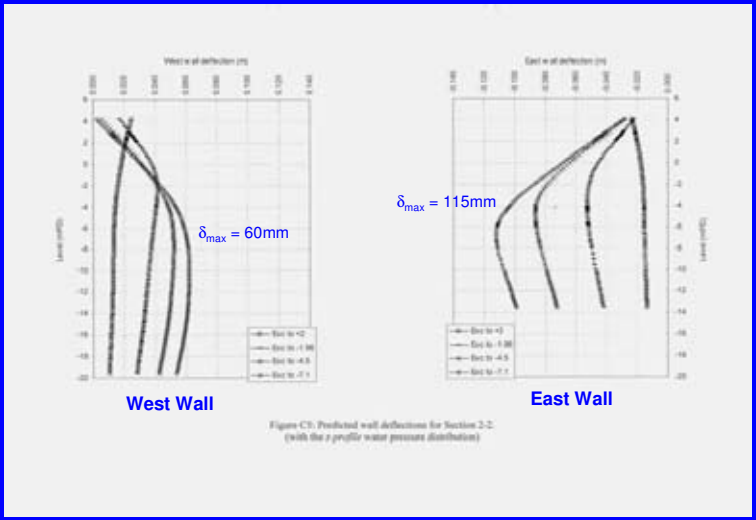
Transverse Cross Section



Elevation of Wall D
(Showing Grouting Ground Improvement)



Finite Element Analysis
(East-West Section)



Wall Deflection (East-West Section)

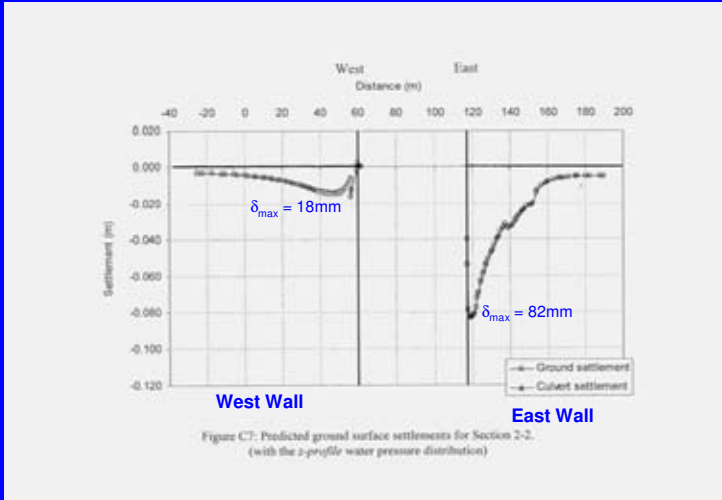
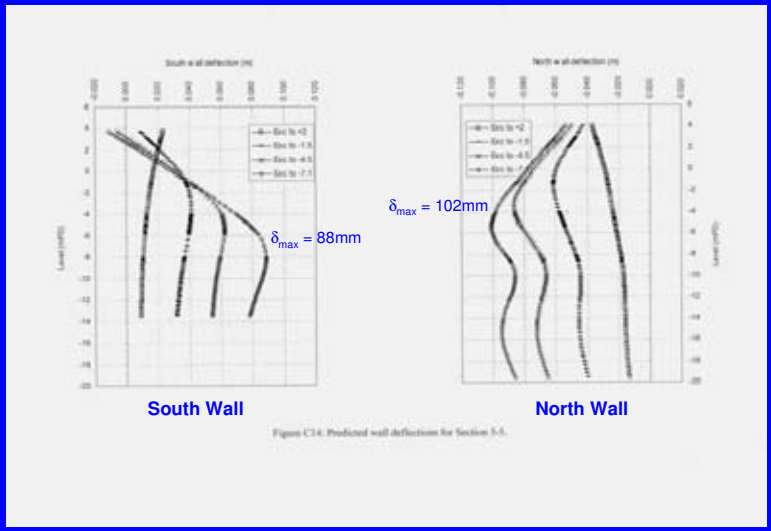


Figure C7: Predicted ground surface settlements for Section 2-2.
(with the *z-profile* water pressure distribution)

Ground Settlement (East-West Section)



Wall Deflection (North-South Section)

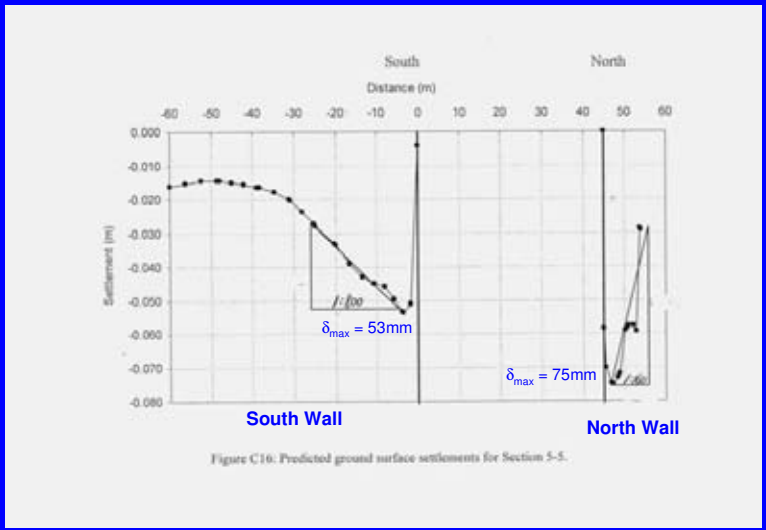
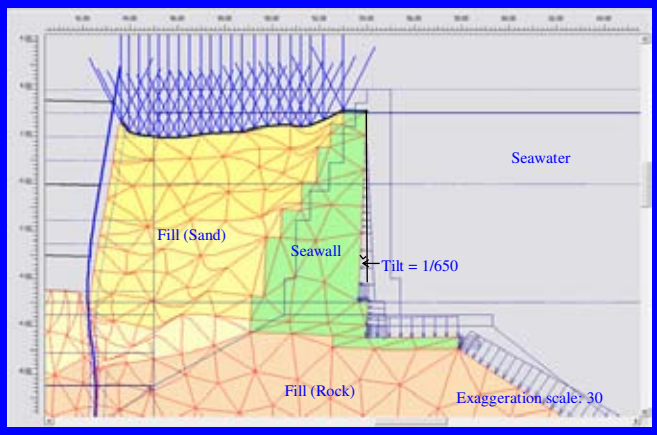
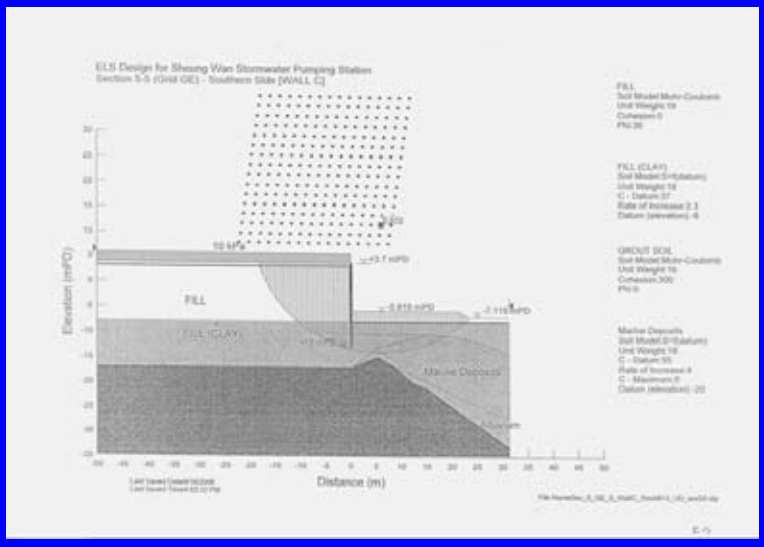


Figure C16: Predicted ground surface settlements for Section 5-5.

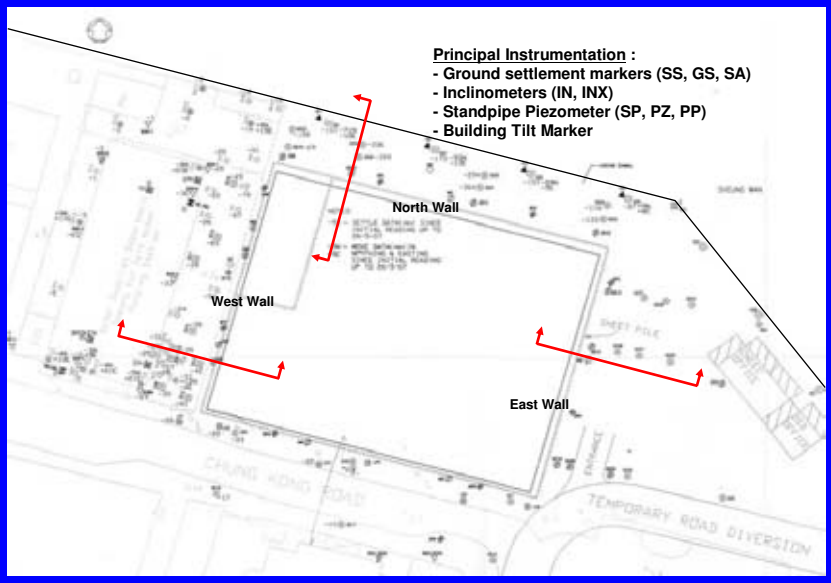
Ground Settlement (North-South Section)



Deformation of Seawall

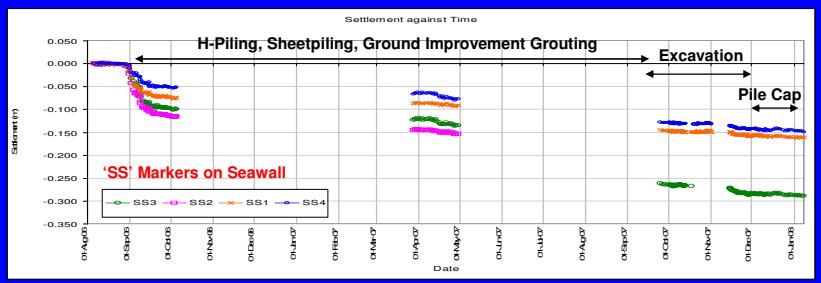


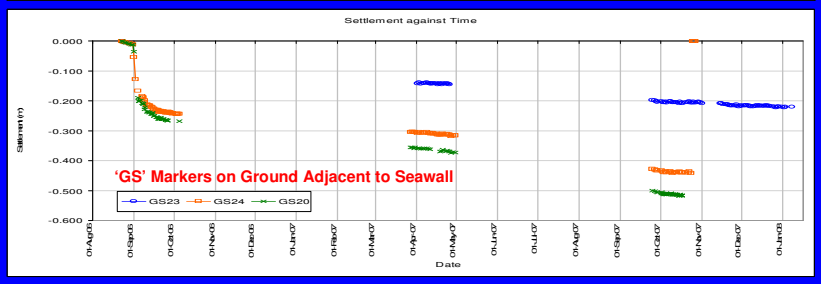
Slope Stability Analysis
(South Wall)



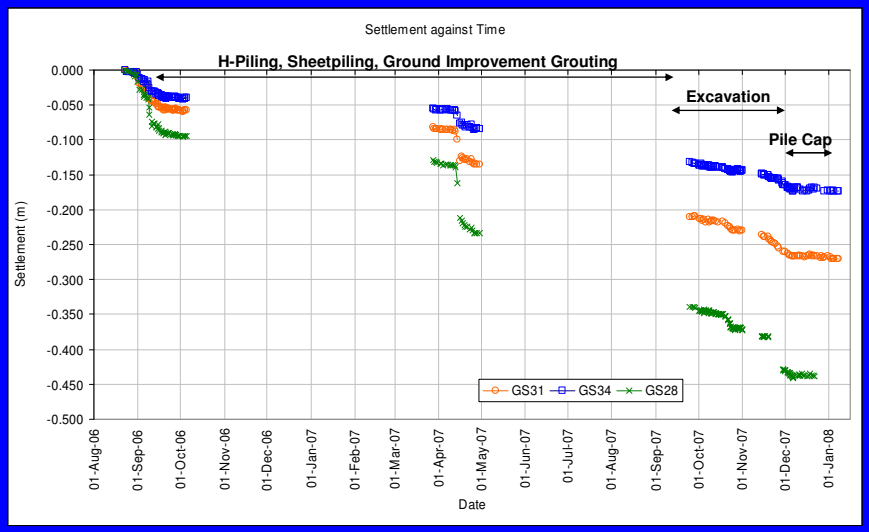
Instrumentation Layout Plan

Outline Construction Programme
for Key Activities

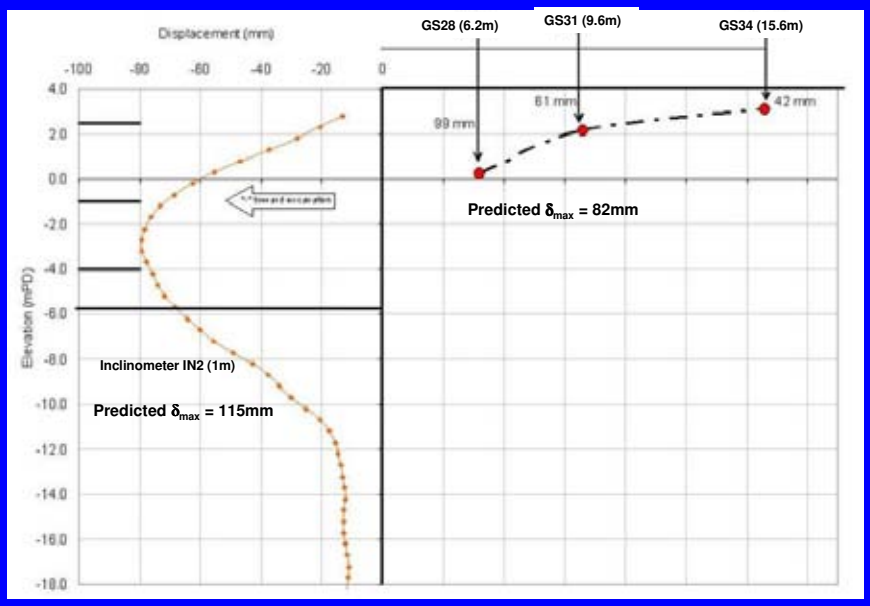




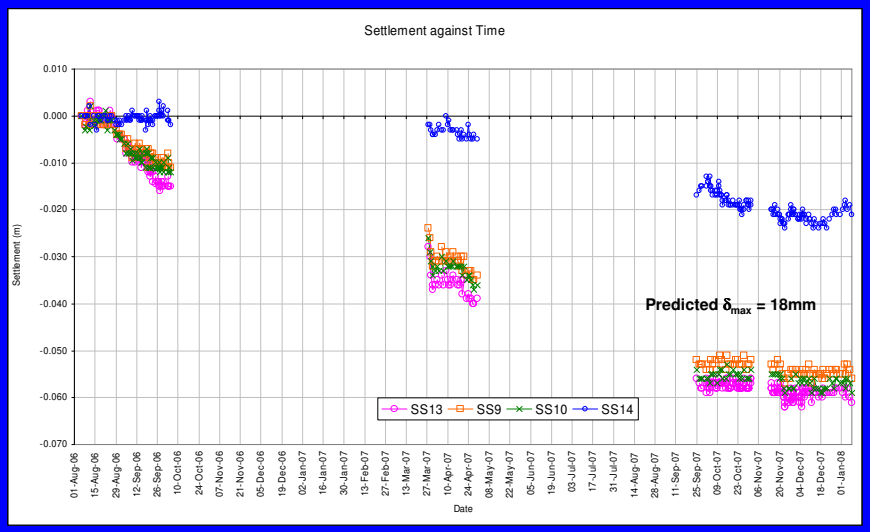
Ground Settlement Time Plot behind North Wall (Seawall)



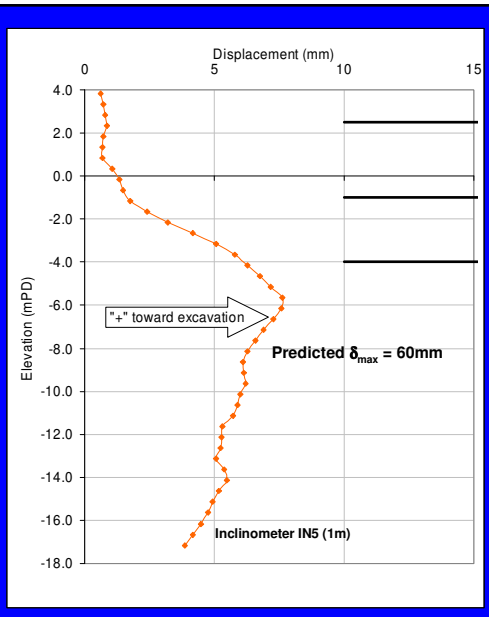
Ground Settlement Time Plot behind East Wall



Ground Deformation behind East Wall
(due to excavation only)



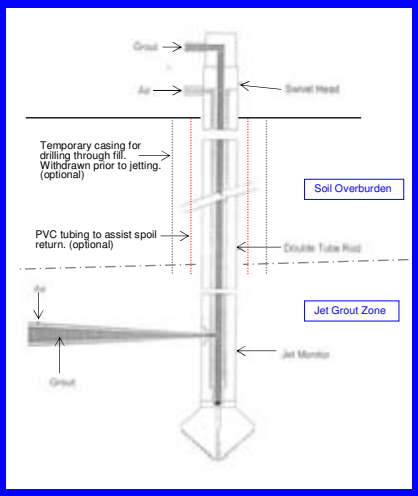
Ground Settlement Time Plot behind West Wall



Ground Deformation behind West Wall
(due to excavation only)

Jet grouting

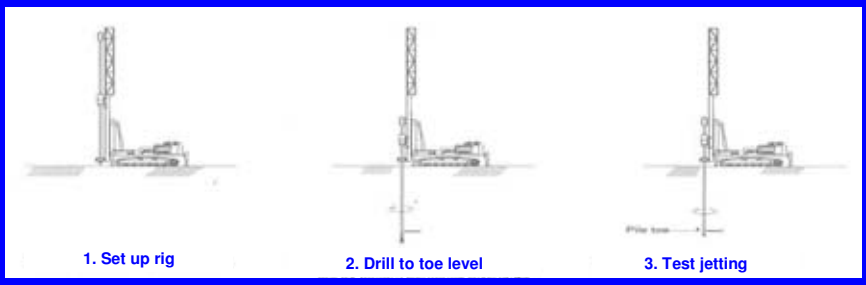
- Jet grout cuts insitu soft clay and mixes that with injected cement
- Disturbed clay is displaced to surface in slurry form
- Jet nozzle is typically 1.4mm to 3mm dia.
- Applicable to more cohesive soils where T.A.M. grouting may not work



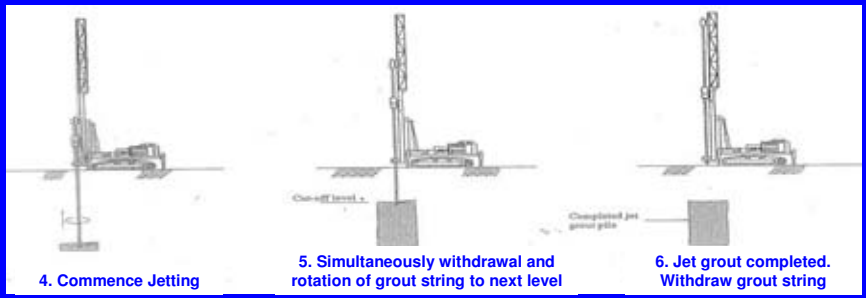
Typical Set up of Jet Grouting

(Double Tube Method)

Ref. : CNCEC



1. Set up rig | 2. Drill to toe level | 3. Test jetting



4. Commence Jetting | 5. Simultaneously withdrawal and rotation of grout string to next level | 6. Jet grout completed. Withdraw grout string

Sequence of Jet Grouting

Ref. : CNCEC

Jet grout parameters

- Jet grout parameters adopted at SWSPS

  Target grouted dia. = 1500 – 2000 mm
  Grout pressure = 300 – 400 bars
  Air pressure = 8 - 12 bars
  Withdraw rate = 13 to 15 min/m
  Rotation rate = 6 – 7 rev/step

- Target strength & stiffness

  UCS = 600 kPa
  Elastic modulus = 150 MPa

Jet Grout Core Sample

Hole S5

Hole S2

(UCS: typically 7-10 MPa, sometimes >40 MPa)

Jet Grout Core Sample

T.A.M. Grout Core Sample

T.A.M. Grout Core Sample

Sheetpiling (by push-in method)

- Suitable in area where vibration is undesirable
- With limited penetration depth
- Difficult to overcome obstruction
- Tend to be more costly

Sheetpiling by push-in method

At SWSPS

- Giken rig with special tool to overcome obstruction (up to 1m)
- Maximum 24m long sheet pile
- Limited to Type IV sheetpile

Ref : Giken Seisakusho Co. Ltd

Sheetpiling by push-in method

Augering to assist penetration

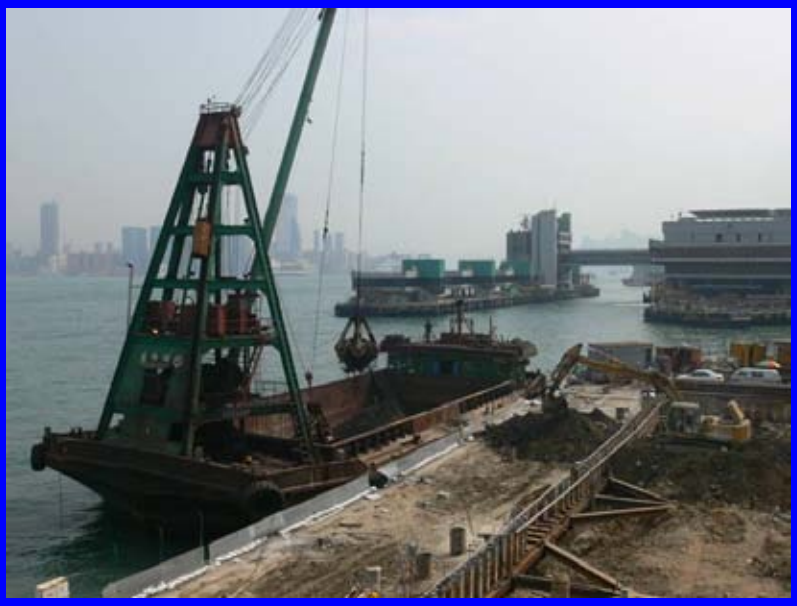
Drilling through Obstructions

Cutter Head for Rock Obstructions

Alignment out-of-line when encountering obstructions

Groundwater leaking through retaining wall

Excavation in progress



Disposal by barge

Installing waling and strut

Excavation completed

Concreting in progress

Concreting in progress
(3 concrete pumps & 13 concrete trucks)

Foundation Completed

Before Commencement

After Completion

Ref. : DSD

Summary

Issues to be considered in ELS design

- Site history
- Site characterization
- Design parameters (drained or undrained)
- Design objective and constraints
- Retaining wall installation effects
- Economy and construction programme

Acknowledgement

- Drainage Services Department
- China National Chemical Engineering Corp
- Hyder Consulting Limited

Thank You !

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