HIGH CAPACITY MICROPILE GROUPS FOR THE CANNON PLACE REDEVELOPMENT IN LONDON

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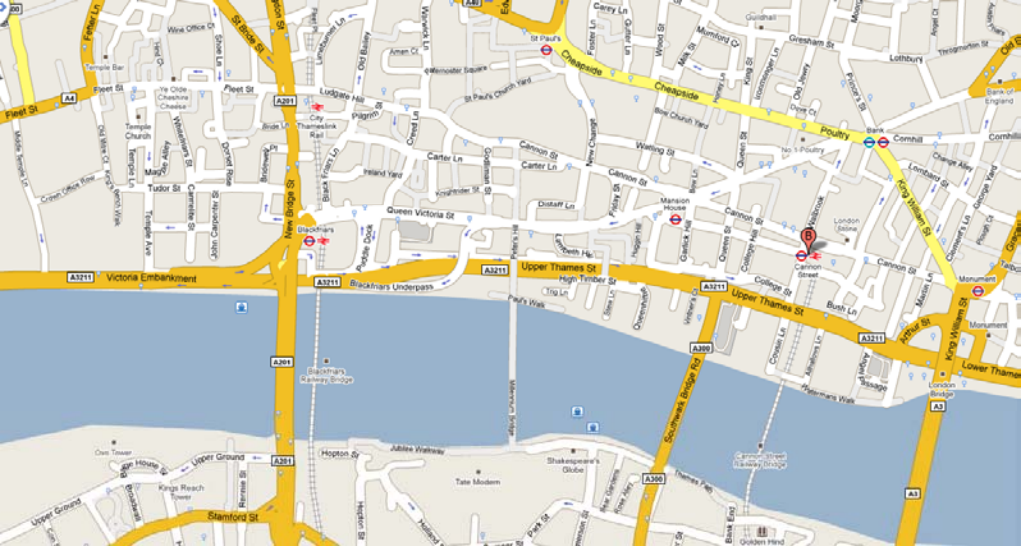
Agenda

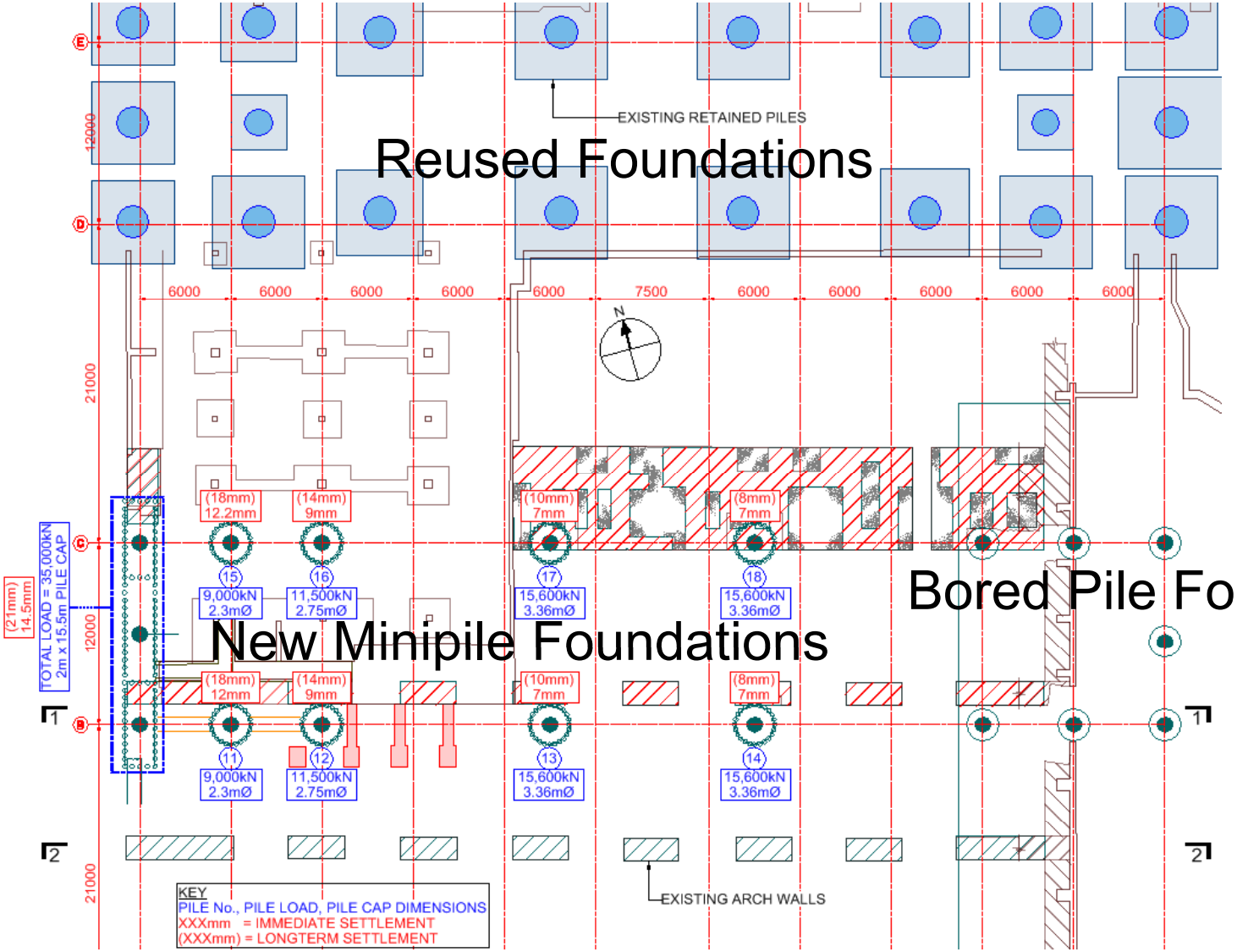
1. **Introduction – Tony Taylor**
2. **Site Description and Geology – Tony Taylor**
3. **Design Philosophy – Tony Taylor**
4. **Preliminary Test Piles – Jim Martin**
5. **Site Works – Jim Martin**
6. **Conclusions – Jim Martin**



1) Introduction

- Location
- Originally constructed in 1868
- Redevelopment in the 1960's
- Brick vaulted viaduct retained

- Present Redevelopment
- Roman Archeology – Scheduled Ancient Monument
- Reused & New Foundations

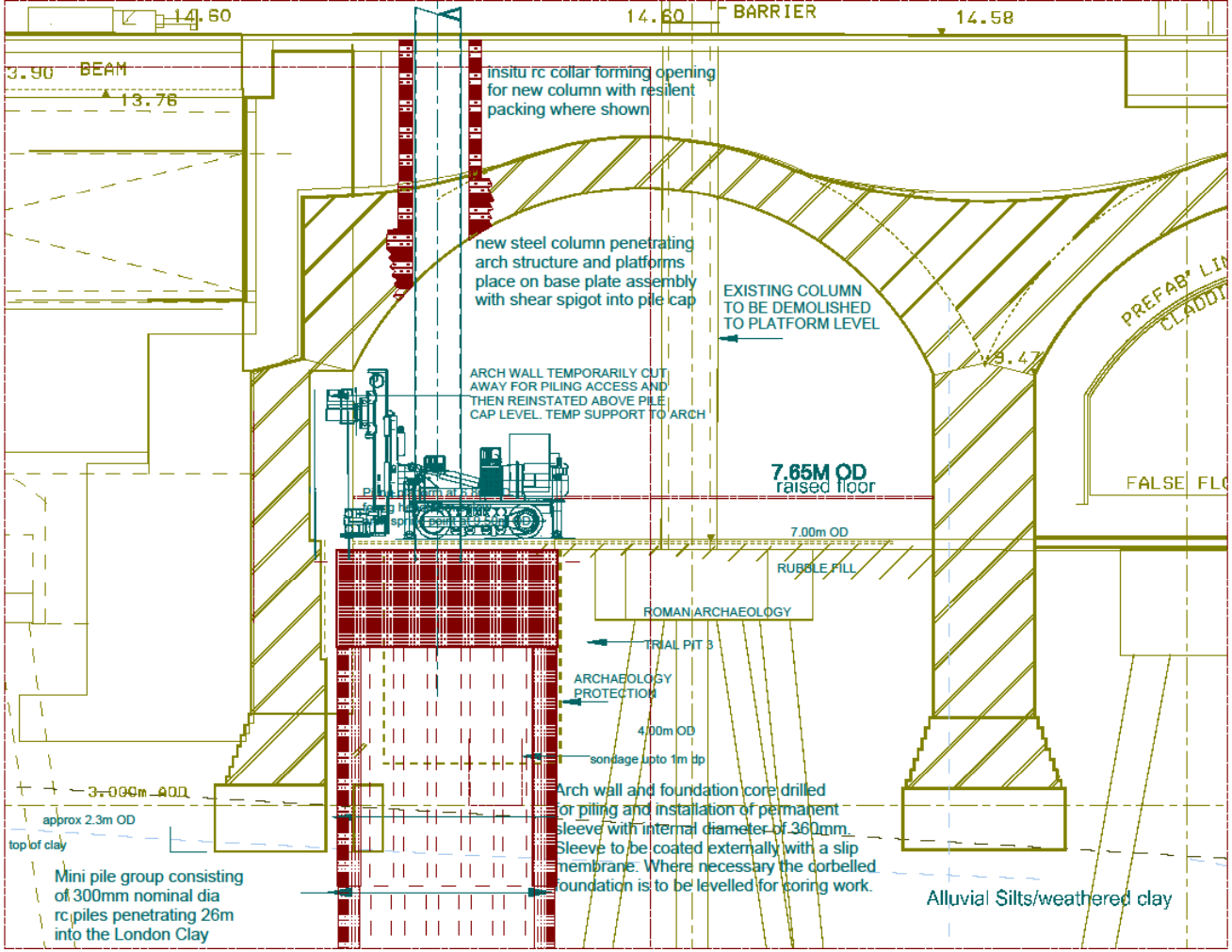


Initial Foundation Scheme

Reused Underreamed Foundations

New Minipile Foundation Groups

New Column loadings range from 9 to 15MN

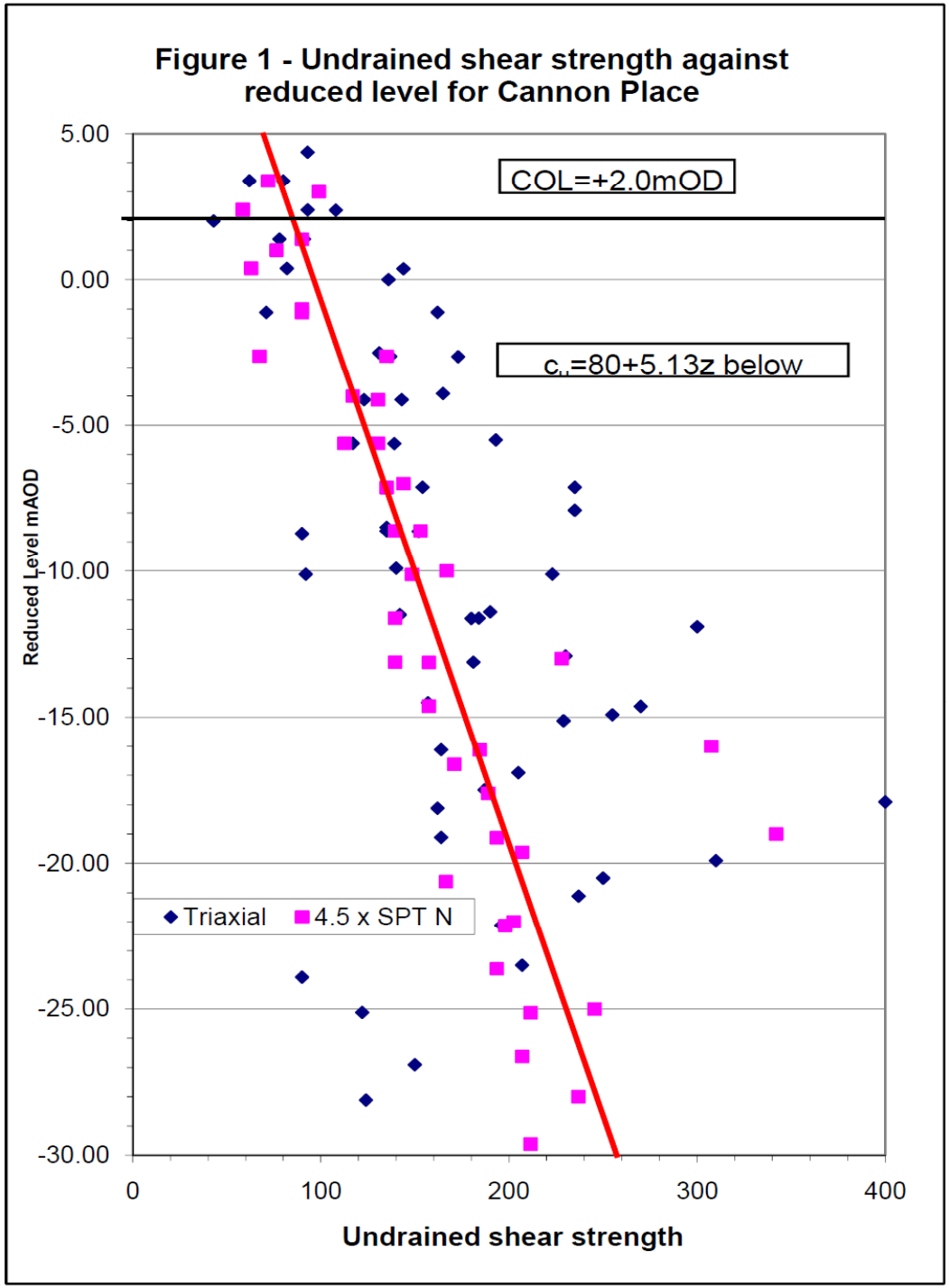


Site Constraints

- Low Headroom 2.7m at Arch Spring
- Existing Arch Viaduct Walls and Foundations
- Working Station Above
- Ancient Scheduled Monument Remains
- 1967 Piled Foundations

2) Geology

- Made Ground
- River Terrace Gravels
- London Clay (scour channels)
- Lambeth Group

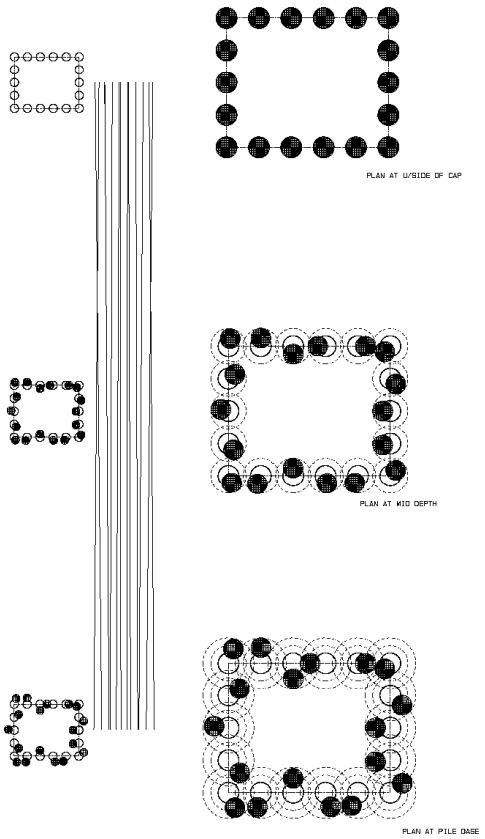


3) Design Philosophy

- Original proposal was hand dug caissons
- Health & safety concerns
- Micropile contractors approached for ideas
- Micropile groups favoured option
- Standard piling tolerances not workable
- 300mm dia piles adopted as best suited to pile group geometry.
- Pile structural capacity important
- Pile spacing's set at 500mm i.e. 1.6D

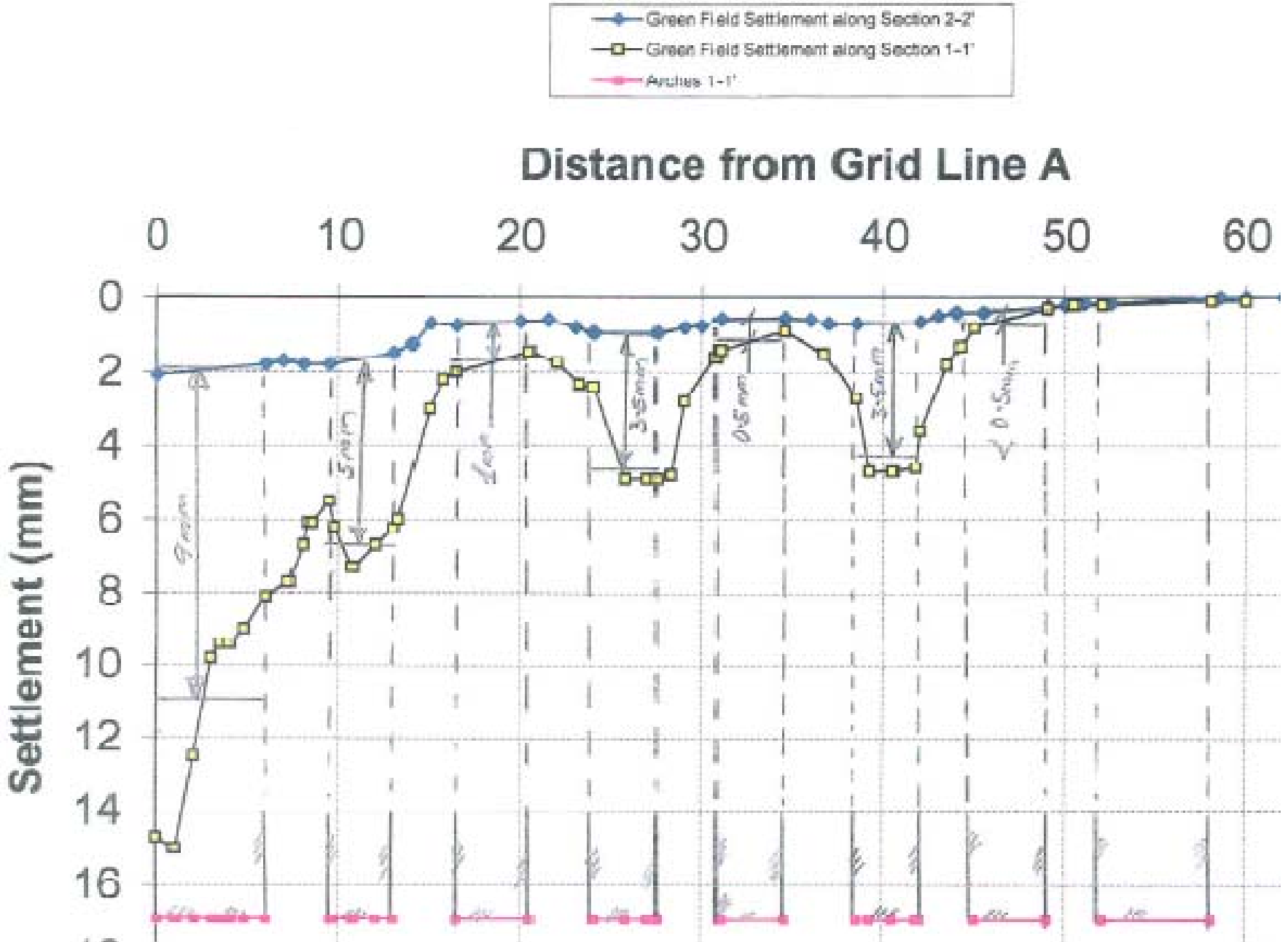
3) Design Philosophy

- Pile group size determined by outer shear perimeter together with bearing over the enclosed base area
- Pile group capacity not greater than sum of individual piles
- Verticality to be better than 1:100 to maintain integrity of pile group geometry
- Settlement not to exceed 10mm to avoid damage to existing viaduct and rail operational issues
- Pile group plan shapes varied from initial circular to rectangular to reduce impact on archaeology and rail viaduct foundations
- Total pile construction depth not to exceed 30m to avoid extended daily construction periods



3) Design Philosophy

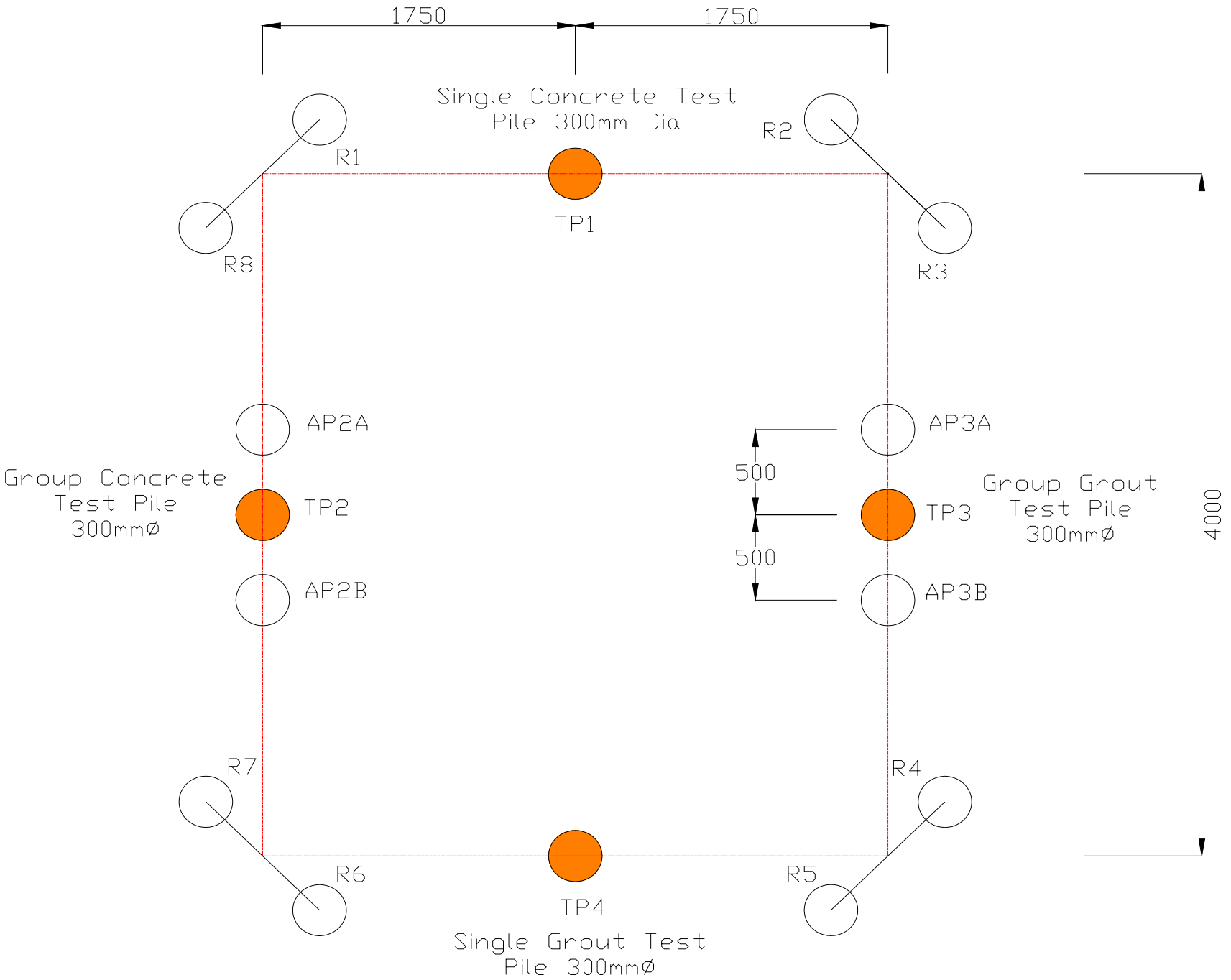
- Steel liners introduced to increase accuracy of position and verticality.
- Permanent liners enable pile installation adjacent to archaeology
- Pile group plan shapes varied from initial circular to rectangular to reduce impact on archaeology and rail viaduct foundations
- Preliminary tests imperative to ratify design assumptions and pile performance with adjacent piles.
- Full load testing of individual contract piles very difficult due to working constraints so dynamic tests undertaken.



Settlement Profiles along Sections 1-1 and 2-2

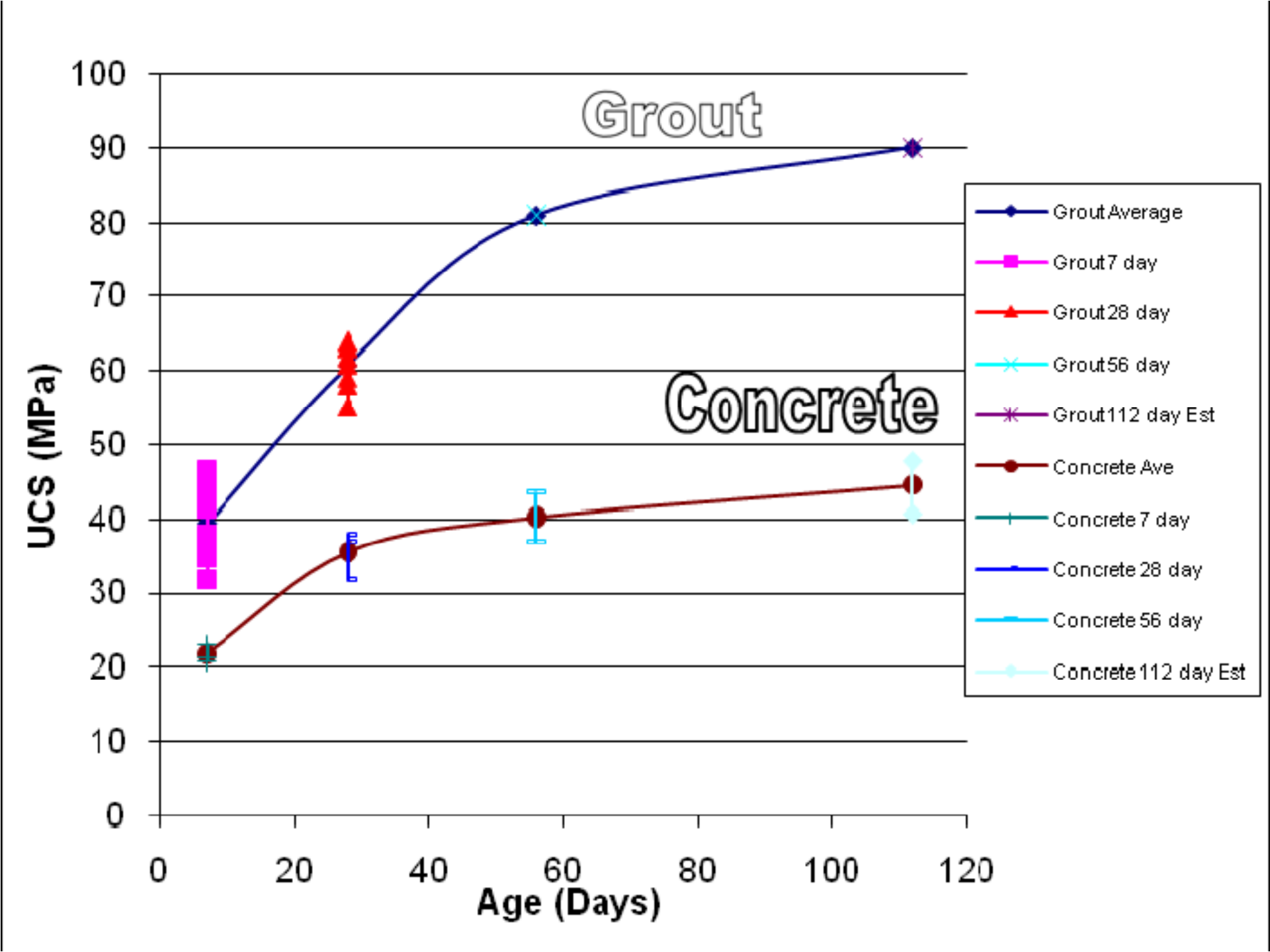
4) Preliminary Test Piles

- Required to confirm
  - Drilling & construction techniques
  - Verticality achievable
  - Calibration of dynamic tests (for working tests)
  - Group versus individual pile behaviour
  - Grout versus concrete behaviour and practicalities
  - Geotechnical design parameters


1750
1750
Single Concrete Test
Pile 300mm Dia
R1
R2
TP1
R8
R3
AP2A
AP3A
Group Concrete
Test Pile
300mmØ
TP2
500
TP3
Group Grout
Test Pile
300mmØ
500
AP2B
AP3B
4000
R7
R4
R6
R5
TP4
Single Grout Test
Pile 300mmØ


MCGEE

Excellent verticality of ~1 in 500 achieved


Grout
Concrete
UCS (MPa)
Age (Days)
0
10
20
30
40
50
60
70
80
90
100
0
20
40
60
80
100
120
Grout Average
Grout 7 day
Grout 28 day
Grout 56 day
Grout 112 day Est
Concrete Ave
Concrete 7 day
Concrete 28 day
Concrete 56 day
Concrete 112 day Est

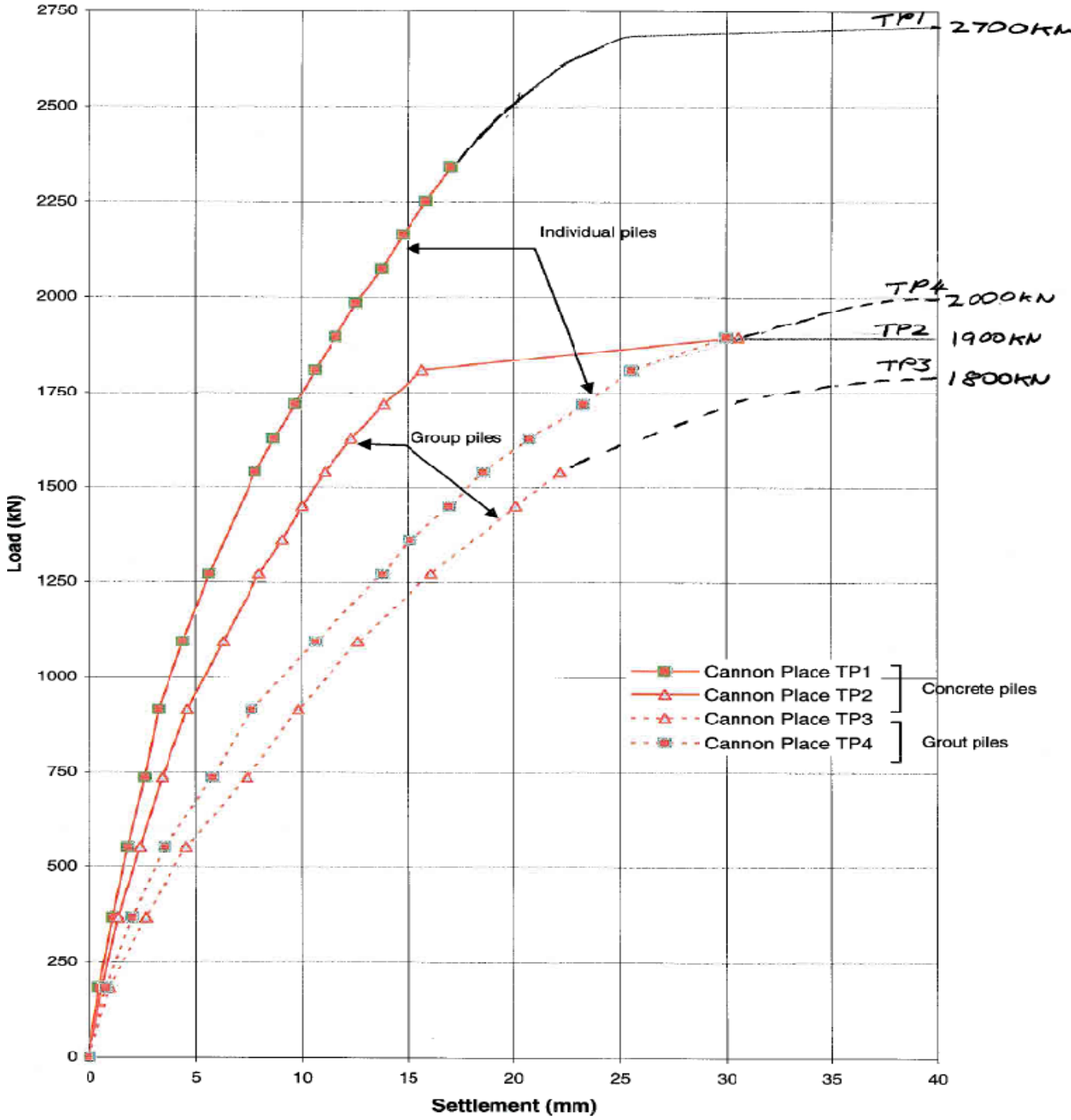
Advantages of Concrete	Disadvantages of Concrete	Advantages of Grout	Disadvantages of Grout
Fast	Reliant on concrete supplier	Mix as and when required	Slow
Cost effective	Difficult to obtain small quantities	Can mix small quantities	Expensive
Good pile performance	Require areas for concrete mixer delivery and pump	Small plant can be moved to minimise pumping distance	Noisy & dusty on site
	Inevitable debris left in base	Debris flushed out of base	

Advantages and Disadvantages of Concrete and Grout

Preliminary Test Pile Arrangement – max test load = 2,400kN

Static pile test Results – (Dynamic Tests showed good correlation up to 800kN)

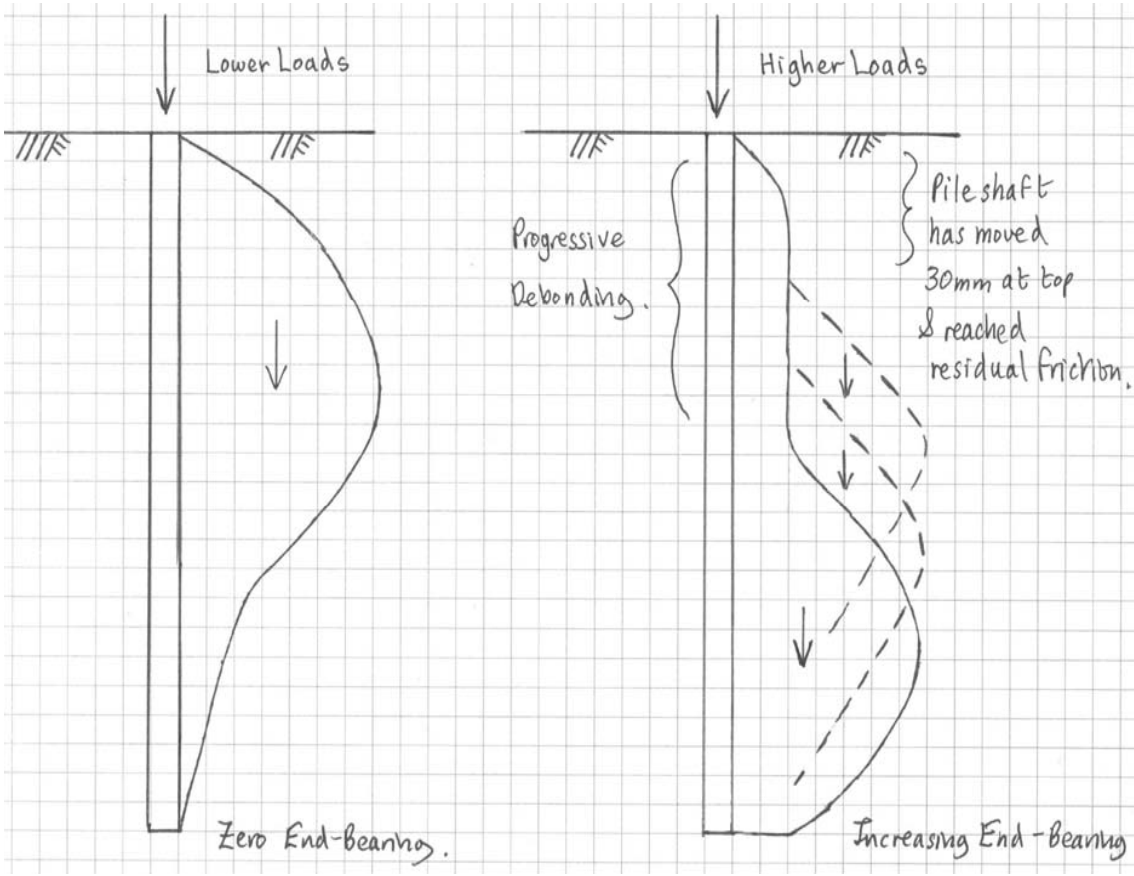
Ultimate Pile Capacity defined as 30mm of pile head settlement



Pile Test No	Concrete / Grout	Group / Single	Ultimate Load from Test & Prediction, Q_{ult} (kN)	Back Calculated α-value
TP1	Concrete	Individual	2,700	0.592
TP2	Concrete	Group	1,900	0.405
TP3	Grout	Group	1,800	0.381
TP4	Grout	Individual	2,000	0.428
		Average concrete alpha α		0.499
		Average grout alpha α		0.405
		Average group alpha α		0.393
		Average overall alpha α		0.452

Discussion on Test Pile Results:

- Low adhesion factor due to progressive debonding (l/d>100) or smearing?
- High adhesion factor in single concrete pile due to installation of 26m deep central 63mm rebar **after concreting?**

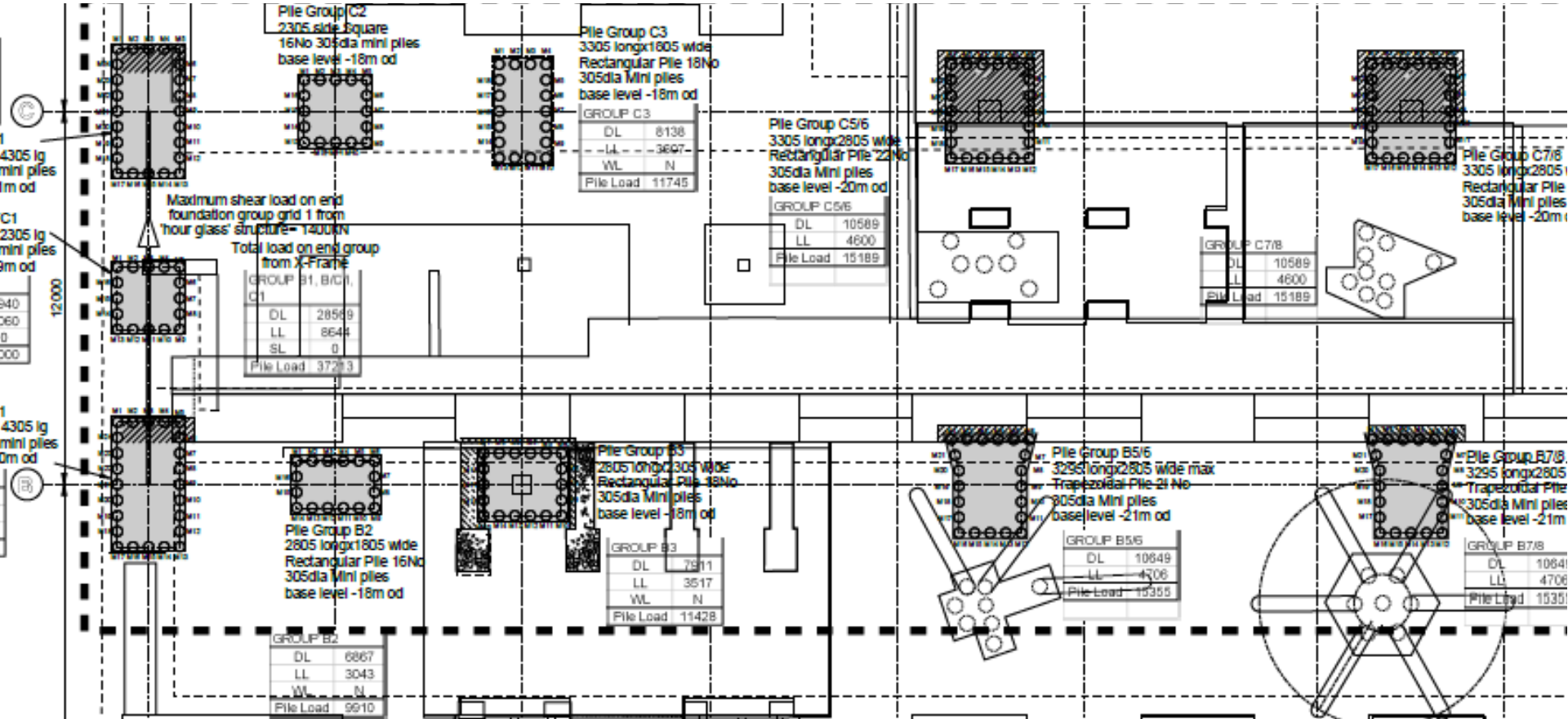


Adopted design parameters for main works

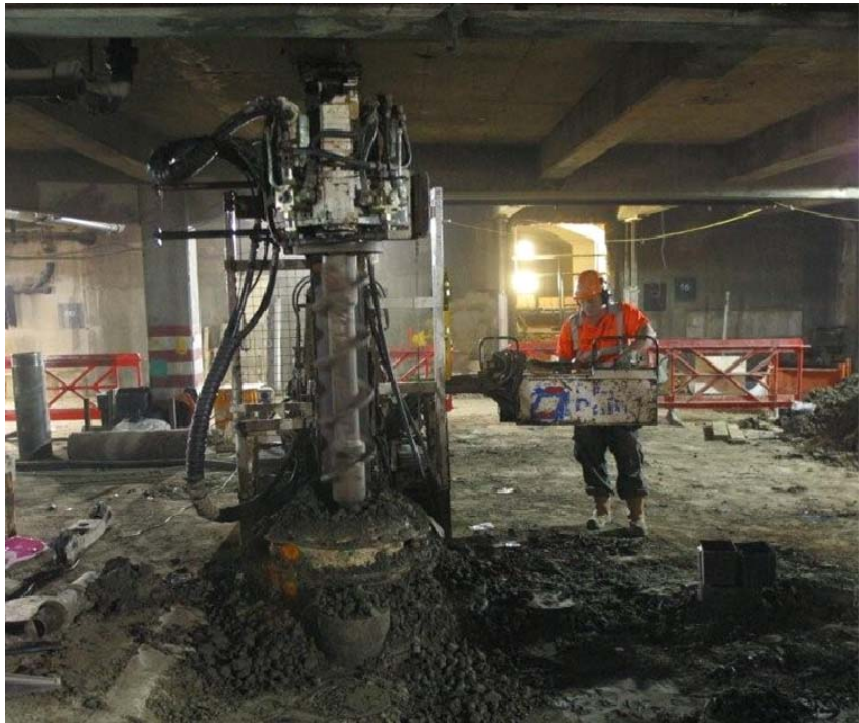
- Adhesion factor = 0.40
- c_u = (80 + 5.13 z) kN/m^2, z = depth below +5.00m OD
- Bearing Capacity Factor = 9.0
- FOS of 2.0

5) Site Works

- 190 micropiles installed during late 2008 at 2 to 3 /shift
- Excellent verticality's achieved
- Pumped concrete worked well



Target slump 185mm important (range 160 to 210mm)



6) Conclusions

- Micropile groups offer advantages over hand dug caissons for large column loads in restricted headroom
- Preliminary testing imperative on complex projects, including time to use results.
- Adhesion factor of 0.4 appropriate for long slender micropiles in London Clay
- Concrete can offer advantages over grout