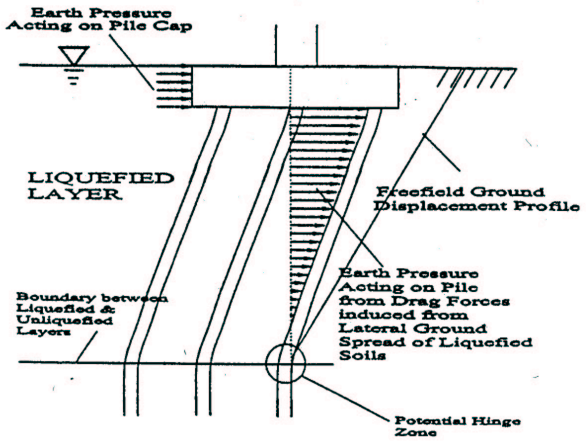
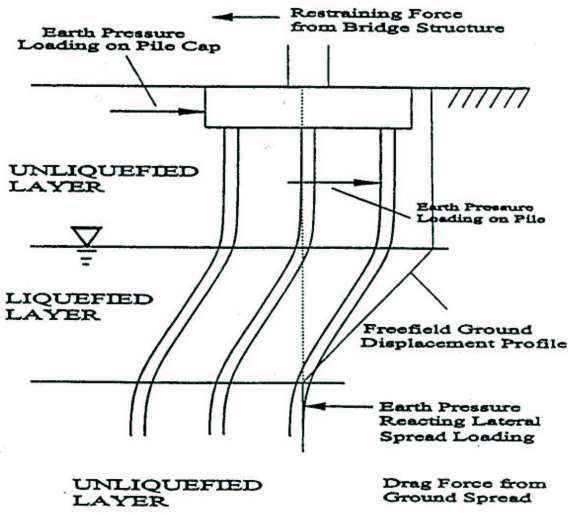
KEY ISSUES RELATED TO PILE GROUP IN SPREADING LIQUEFIED GROUND WITH A NONLIQUEFIED SURFACE LAYER

Ignatius Po Lam, Earth Mechanics, Inc.



(b) Lateral Spread Loading Problem
for Liquefied Layer above Unliquefied Layer



(b) Lateral Spread Loading Problem
for Unliquefied Layer above Liquefied Layer

Figure 2-29 Two Generic Soil Conditions for Lateral Spread Pile Loading Problem

Two Cases of Liquefaction Problems

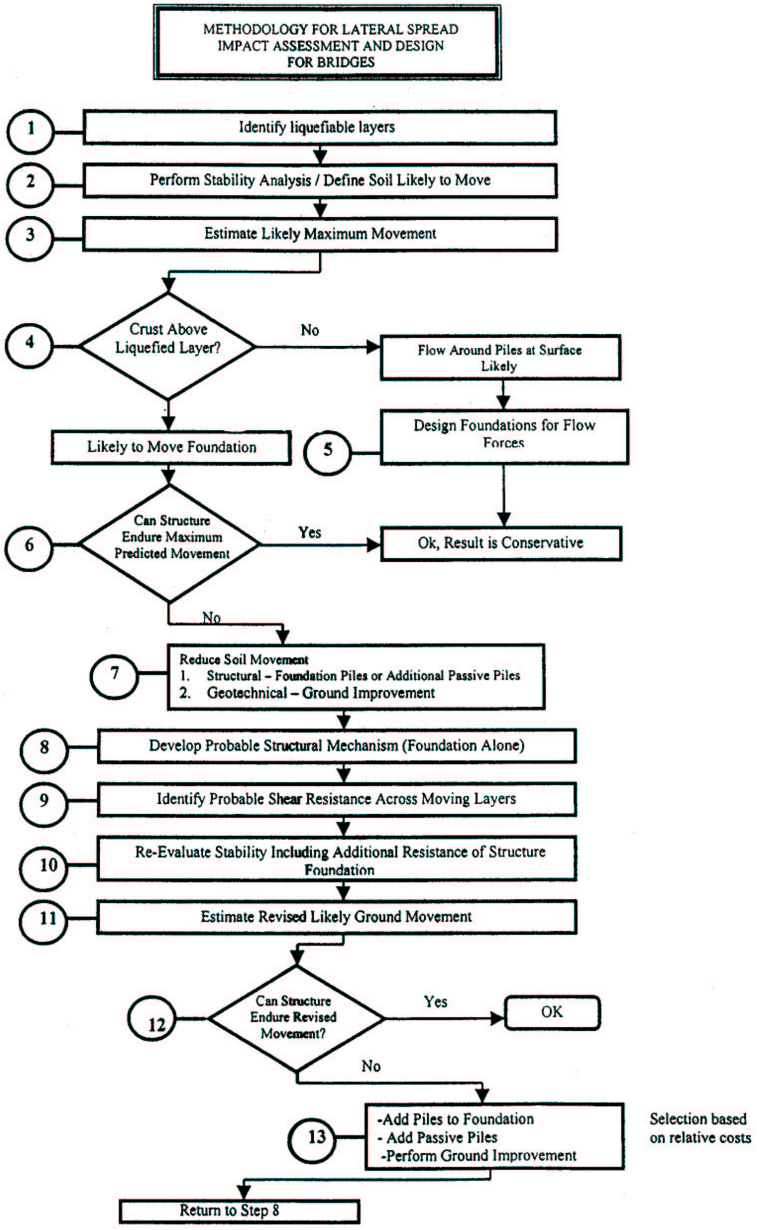
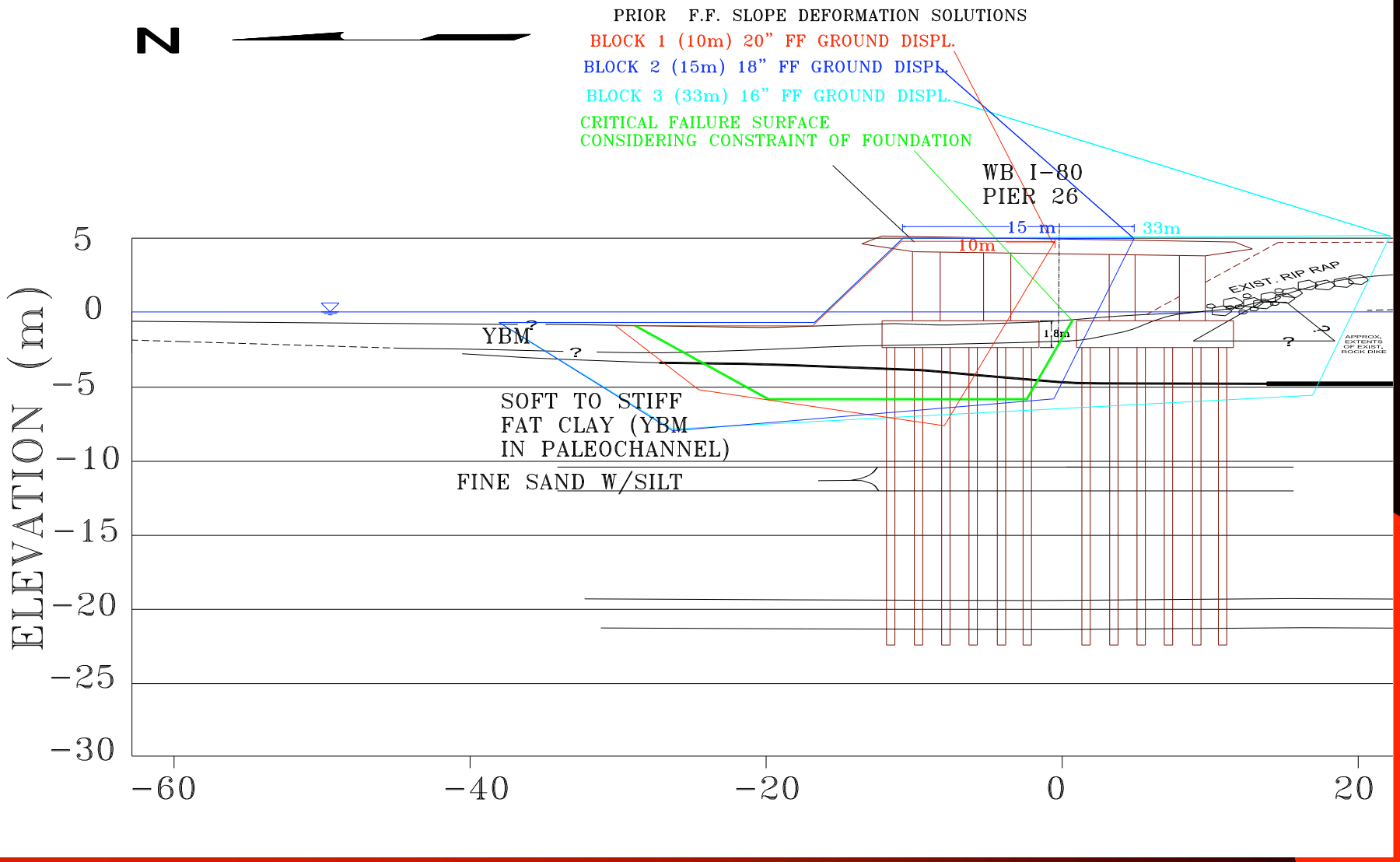
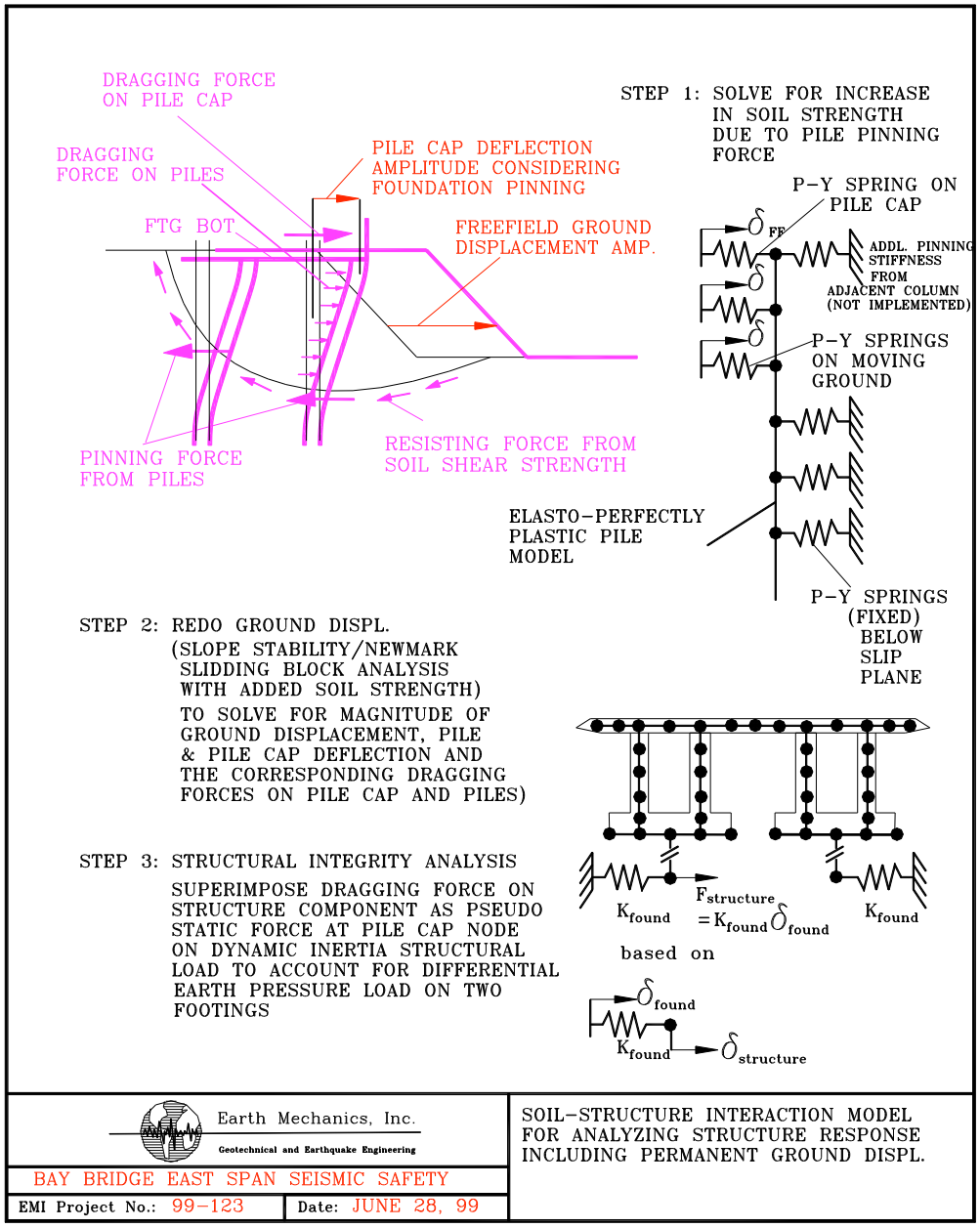


Figure 4 Lateral Spread Design Flow Chart (MCEER 2001)

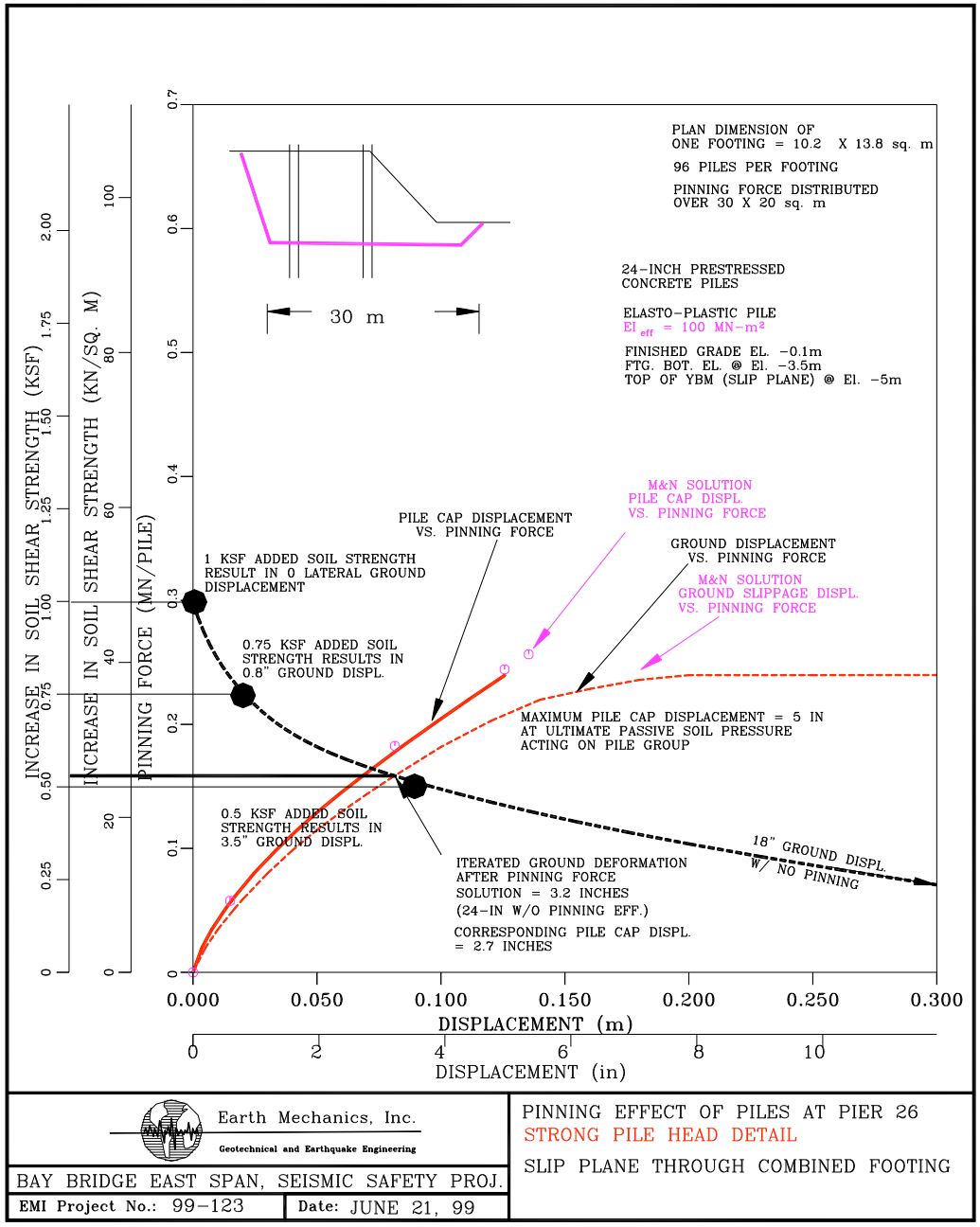
MCEER Recommendations for Bridge Foundations



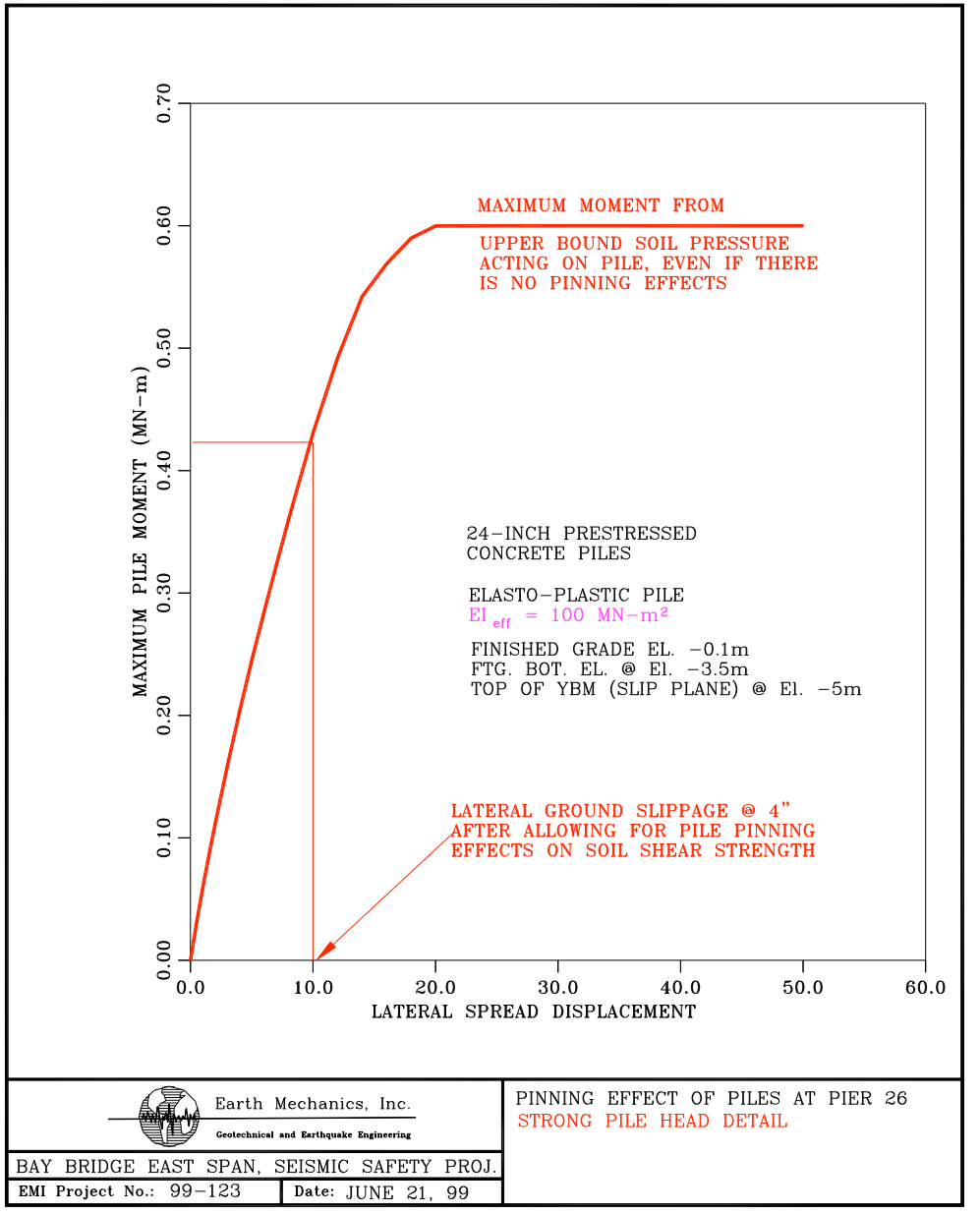
Pile Pinning Effect on Ground Displacement



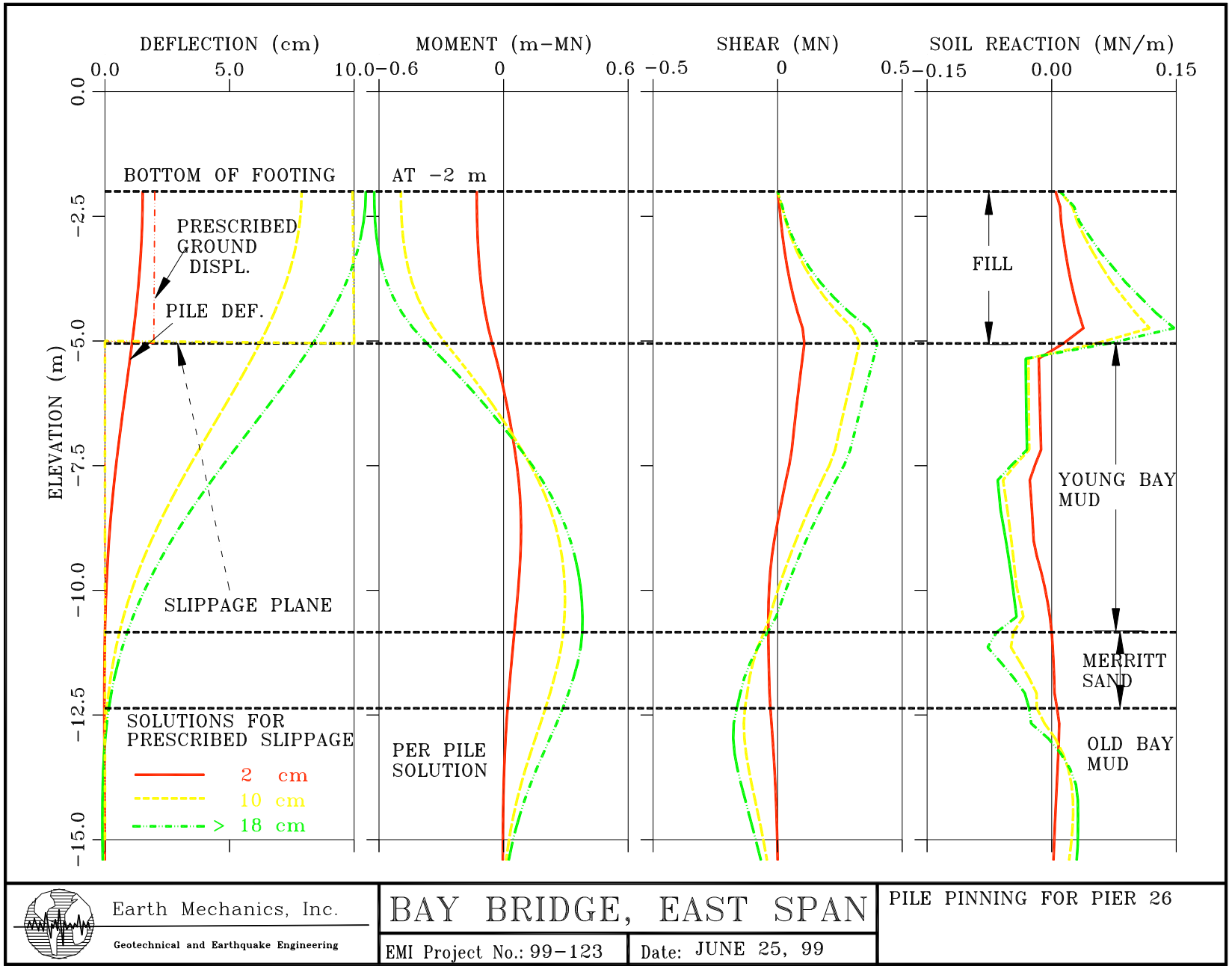
Analysis Modules for Pile Pinning Effects on Ground Displacement



Ground Displacement including Pile Pinning



Pile Moment vs. Ground Displacement



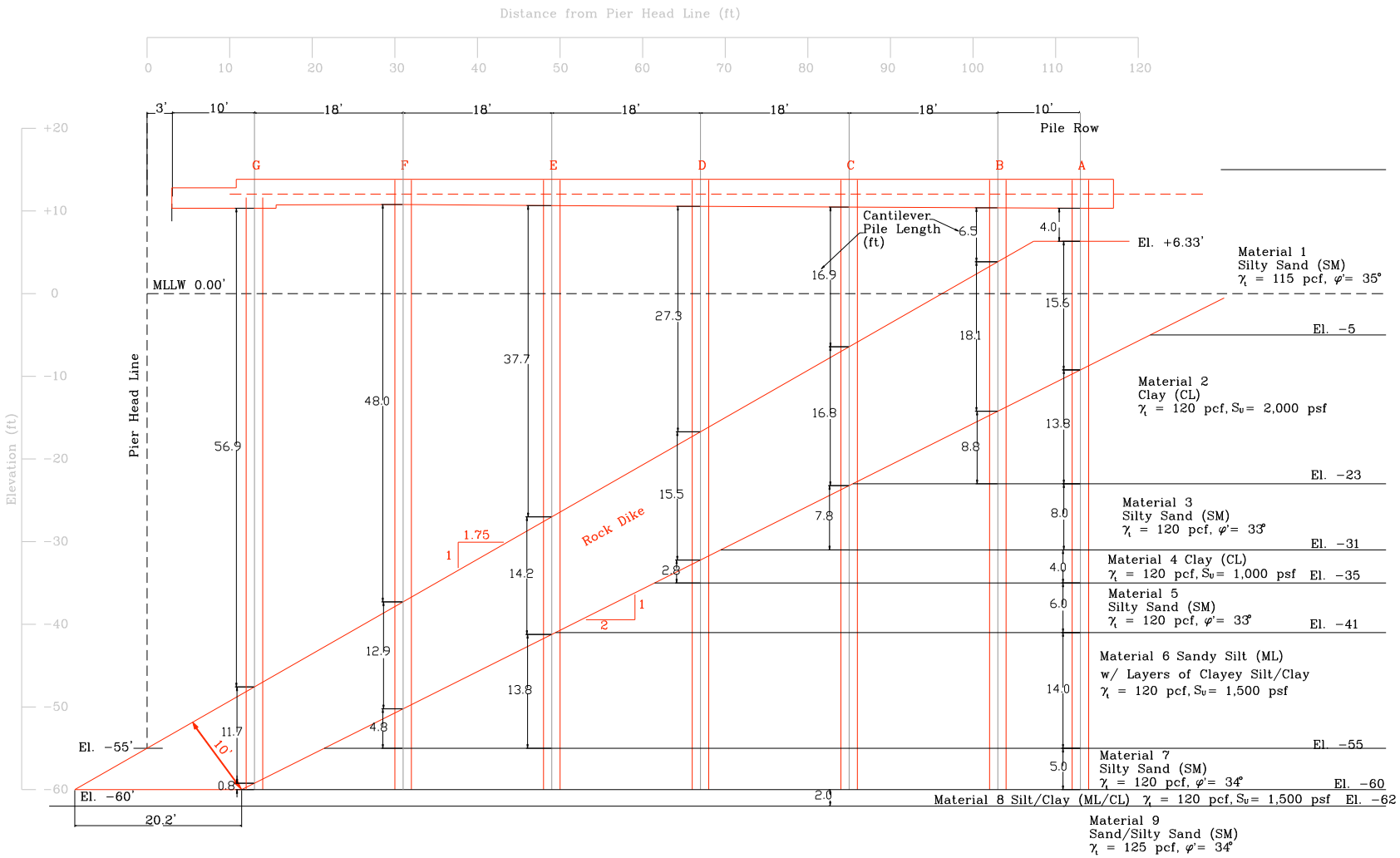
Earth Mechanics, Inc.
Geotechnical and Earthquake Engineering

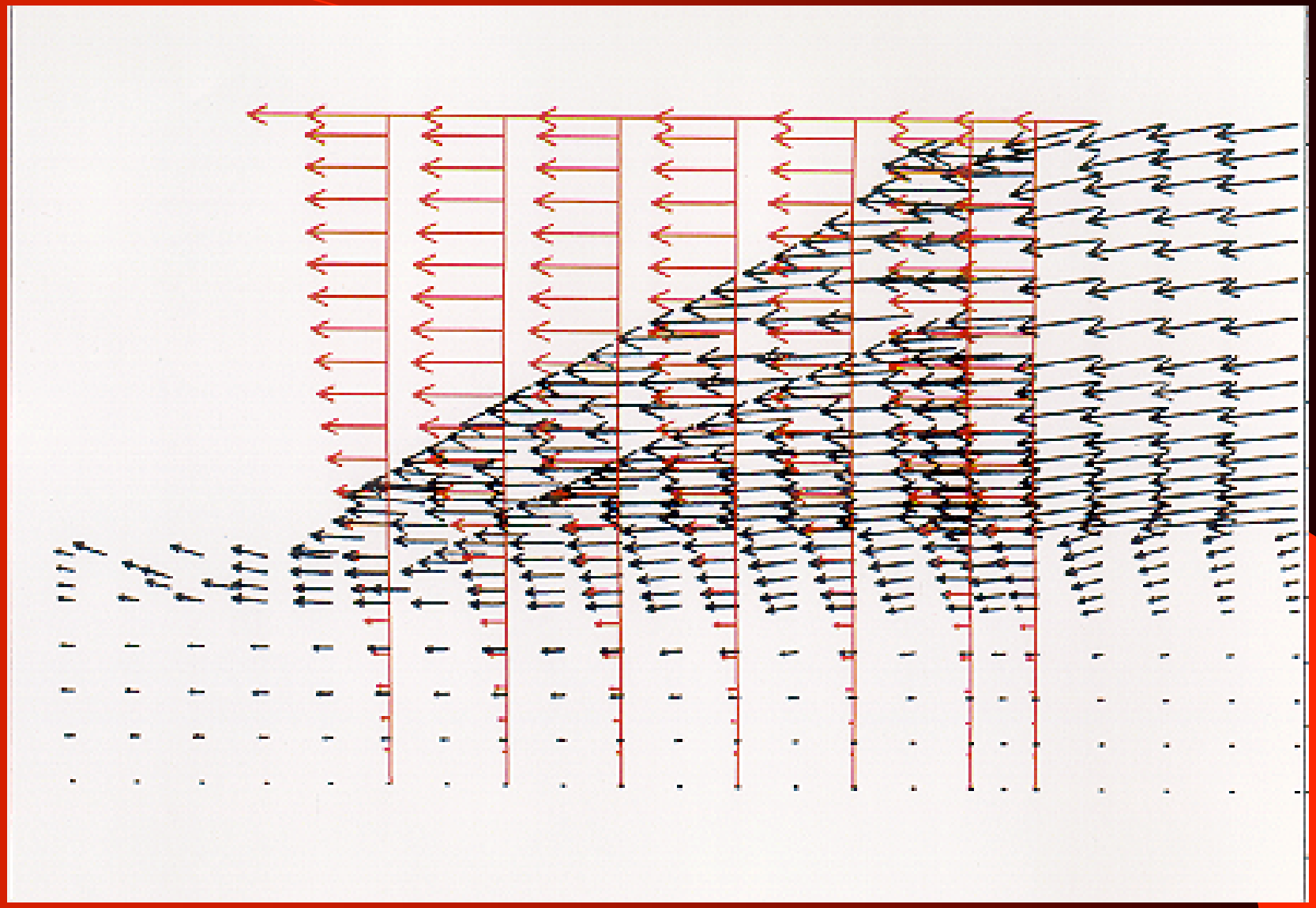
BAY BRIDGE, EAST SPAN

PILE PINNING FOR PIER 26

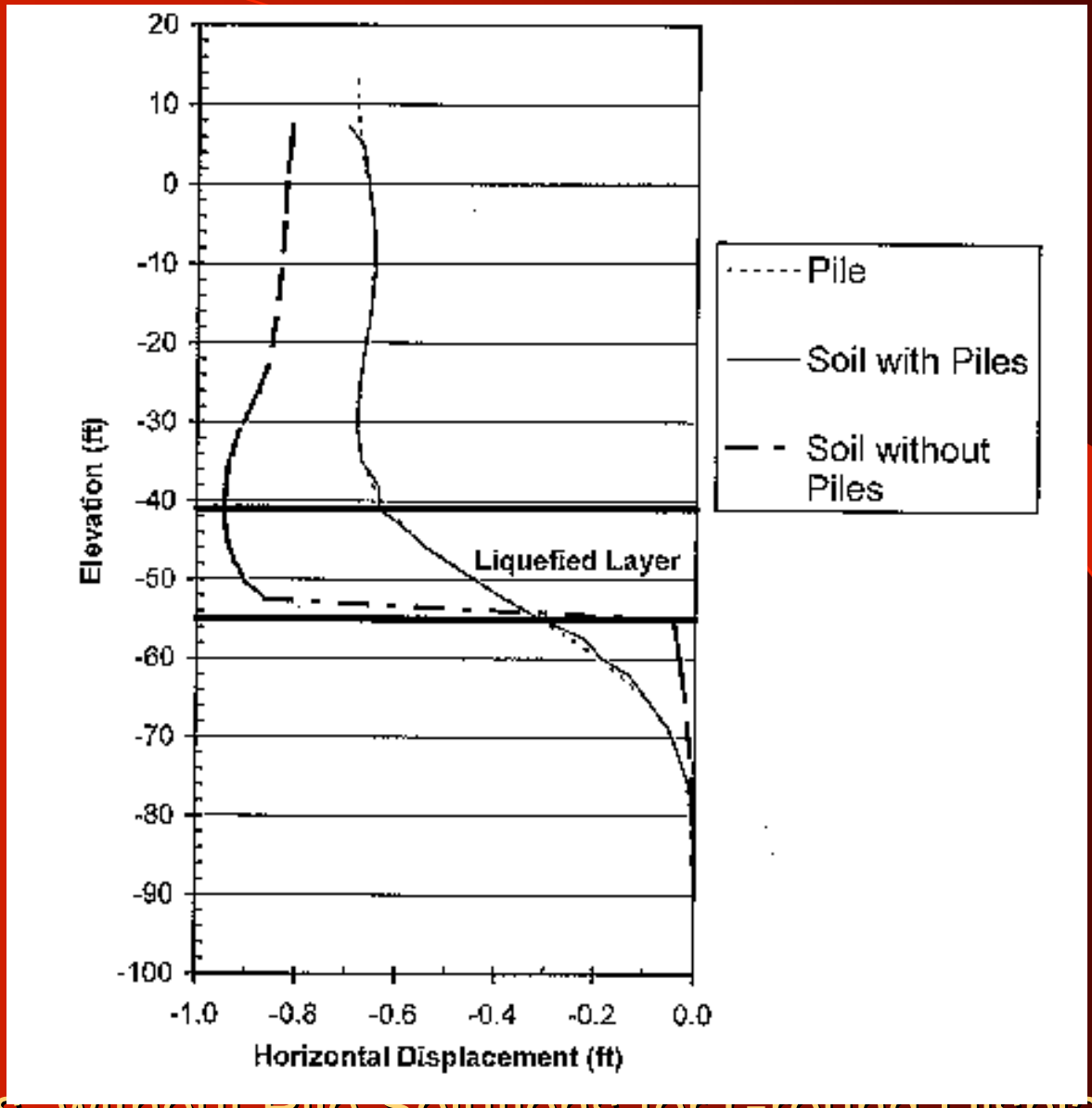
EMI Project No.: 99-123

Date: JUNE 25, 99


Distance from Pier Head Line (ft)
0
10
20
30
40
50
60
70
80
90
100
110
120
Elevation (ft)
+20
+10
0
−10
−20
−30
−40
−50
−60
3'
10'
18'
18'
18'
18'
18'
10'
Pile Row
G
F
E
D
C
B
A
Pier Head Line
MLLW 0.00'
Cantilever Pile Length (ft)
6.5
4.0
El. +6.33'
16.9
15.5
Material 1
Silty Sand (SM)
γt = 115 pcf, φ'= 35°
El. −5
27.3
18.1
37.7
48.0
56.9
16.8
13.8
8.8
Material 2
Clay (CL)
γt = 120 pcf, Su= 2,000 psf
El. −23
15.5
7.8
8.0
Material 3
Silty Sand (SM)
γt = 120 pcf, φ'= 33°
El. −31
Rock Dike
1.75
1
2.8
4.0
Material 4 Clay (CL)
γt = 120 pcf, Su= 1,000 psf
El. −35
14.2
1
2
6.0
Material 5
Silty Sand (SM)
γt = 120 pcf, φ'= 33°
El. −41
12.9
13.8
Material 6 Sandy Silt (ML)
w/ Layers of Clayey Silt/Clay
γt = 120 pcf, Su= 1,500 psf
14.0
4.8
11.7
10.
El. −55'
El. −55
5.0
Material 7
Silty Sand (SM)
γt = 120 pcf, φ'= 34°
El. −60
0.8
El. −60'
2.0
Material 8 Silt/Clay (ML/CL) γt = 120 pcf, Su= 1,500 psf El. −62
20.2'
Material 9
Sand/Silty Sand (SM)
γt = 125 pcf, φ'= 34°



Modification of Site Response due to Presence of Pile



With vs. Without Pile Solutions for Ground Displacement Profiles

KEY ISSUES

Kinematic soil-pile interaction has been concern to geotechnical engineers especially at poor ground conditions, such as spreading liquefiable grounds, simplified methods seems to be overly conservative especially penalizing the use of large diameter hollow cylinder concrete piles.

Conventional geotechnical approach tend to result in overly conservative solutions and could be very misleading.

Past case histories largely reviewed pile damage at pile head connections, rather than in deep seated in ground zones. Is it because pile damage at deep in ground zones are not known. In that case, since that such damage do not compromise serviceability, is it too conservative to design foundation to essentially elastic response.

KEY ISSUES

What is the proper procedure to estimate ground displacement profile for soil-pile interaction analyses to assess pile performance in kinematic pile loading problem in liquefiable grounds. Can we really do a meaningful job based on freefield site response approach, without considering reinforcing effects of the piles?

What p-y curve procedure should we use in kinematic pile loading analyses. How good is conventional p-y curves from pile load tests data at surficial soil-pile interaction zone to be used for deeper soil-pile interaction zones. Since that maximum pile moment will be at the competent soil layer very close to liquefied soil zone, how will the adjacent liquefied soil alter the p-y curves at the unliquefied soil layer?

Do we need to superimpose loading conditions from the conventional inertial load case to the deep-seated kinematic pile loading problem?

What analyses can we do to solve the problem in design processes: (1) for the basic inertial response problem and (2) for the deeper ground curvature problem?