LESSON 6

TOPIC 2

Treatment for Embankment Settlement Problems

TREATMENT FOR EMBANKMENT SETTLEMENT PROBLEMS

Lesson 6 - Topic 2

Slide 6-2-1

TREATMENT FOR EMBANKMENT SETTLEMENT PROBLEMS

1. Propose Solutions to Embankment Settlement Problems

ACTIVITIES: Question - Answer

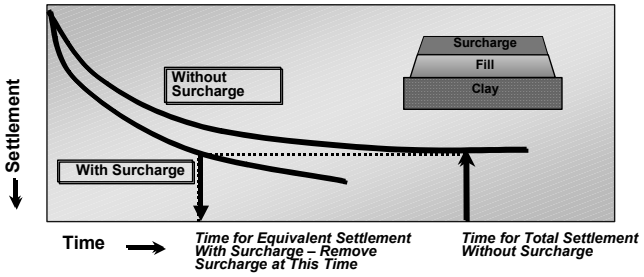
Slide 6-2-2

Solutions for Settlement Problems

- ***Reduce Settlement Amount***
  - ***Lower Grade***
  - ***Excavate and Replace Soft Soil***
  - ***Lightweight Fill***
- ***Reduce Settlement Time***
  - ***Surcharge***
  - ***Vertical Drains***

Slide 6-2-3

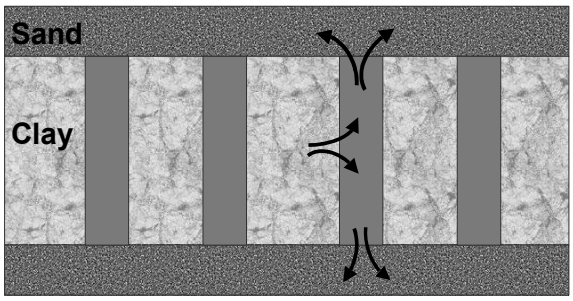
Embankment on Clay Foundation Effect of Surcharge Treatment



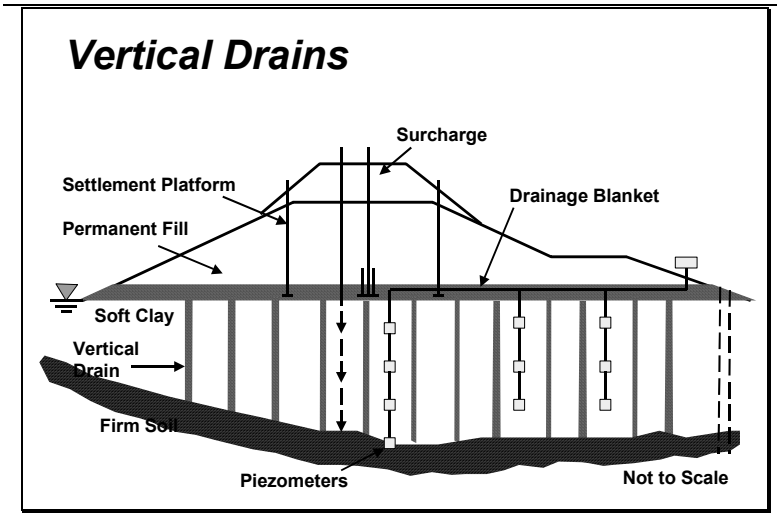
Slide 6-2-4

Slide 6-2-5

Acceleration of Consolidation Using Vertical Drainage



Slide 6-2-6



Slide 6-2-7

Slide 6-2-8

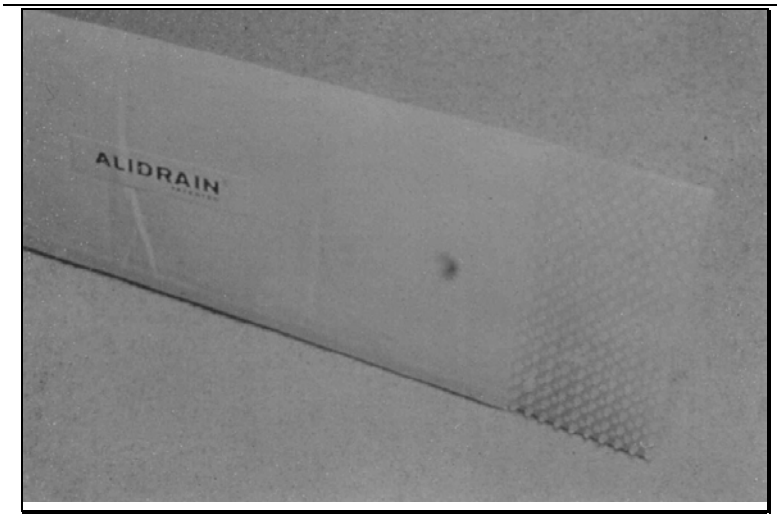
Slide 6-2-9

Vertical Drain Installation Sequence

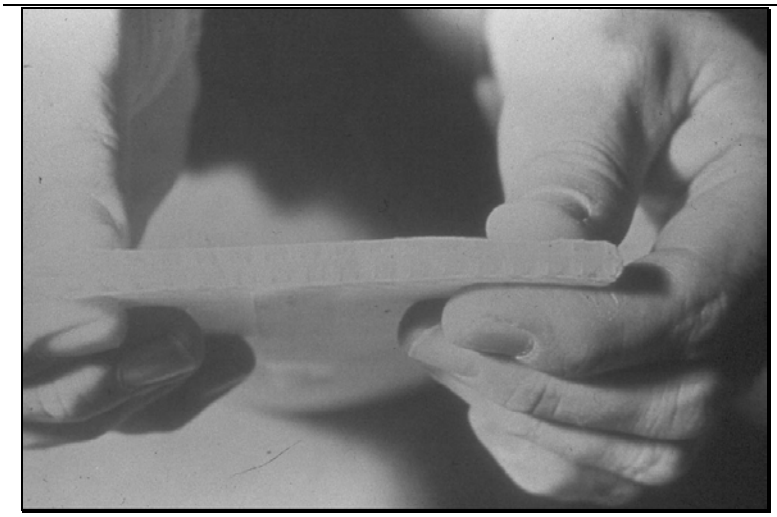
- ***Position Rig at Drain Location***
- ***Place Anchor on Drain End***
- ***Penetrate Mandrel to Desired Depth***
- ***Withdraw Mandrel***
- ***Cut Drain Material Above Drainage Blanket***

Slide 6-2-10

Slide 6-2-11



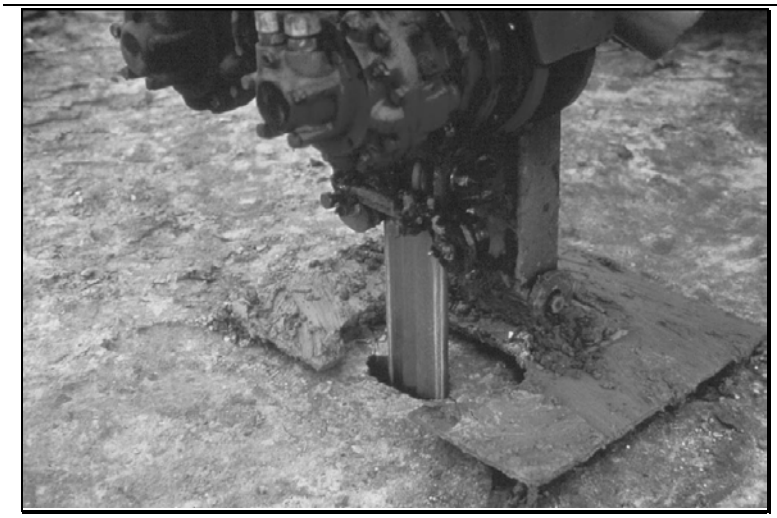
Slide 6-2-12



Slide 6-2-13

Slide 6-2-14

Slide 6-2-15



Slide 6-2-16

Slide 6-2-17

Slide 6-2-18

Slide 6-2-19

SOILS AND FOUNDATIONS WORKSHOP

Site Exploration

Basic Soil Properties

Laboratory Testing

Slope Stability

Embankment Settlement

Spread Footing Design

Pile Design

Construction Aspects

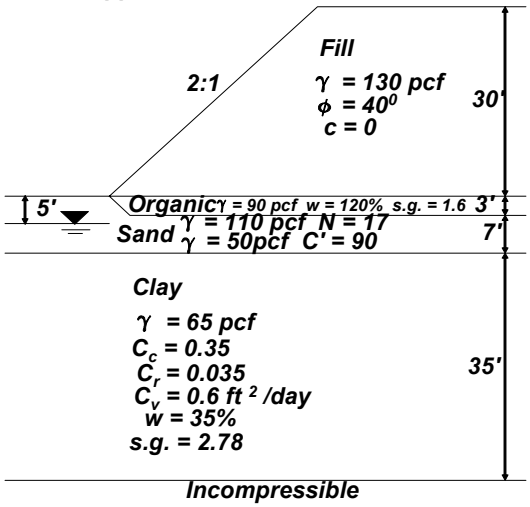
→

Soil Profile
Settlement
Time – Rate
Surcharge
Vertical Drains

Slide 6-2-20

SOILS AND FOUNDATIONS WORKSHOP

Apple Freeway Design Problem
East Approach Embankment Settlement

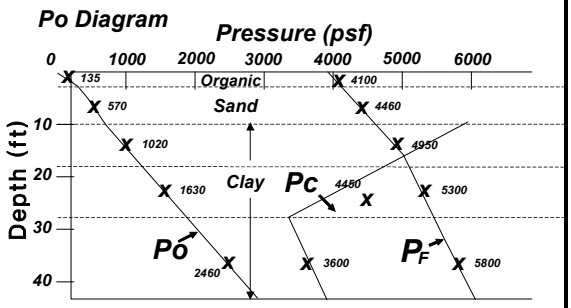


Slide 6-2-21

SOILS AND FOUNDATIONS WORKSHOP

Apple Freeway Design Problem

East Approach Embankment Settlement



Slide 6-2-22

SOILS AND FOUNDATIONS WORKSHOP

Apple Freeway Design Problem
East Approach Embankment Settlement

Total Settlement

Layer 1 - Organic (0' -3')	*19.54"*
Layer 2 - Sand (3' - 10')	*0.83"*
Layer 3 - Clay (10' - 18')	*1.17"*
Clay (18' - 28')	*2.55"*
Clay (28' - 45')	*8.11"*
ΔH_{Total}	*32.20"*

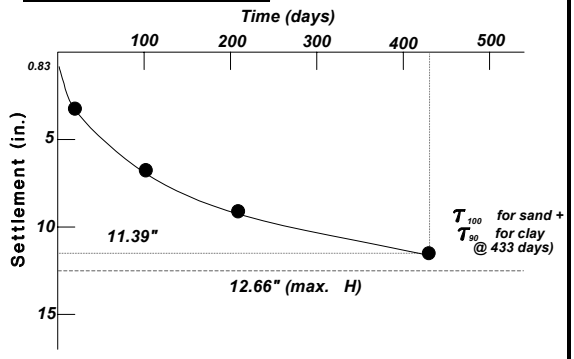
Slide 6-2-23

SOILS AND FOUNDATIONS WORKSHOP

Apple Freeway Design Problem

East Approach Embankment Settlement

Time - Settlement Plot



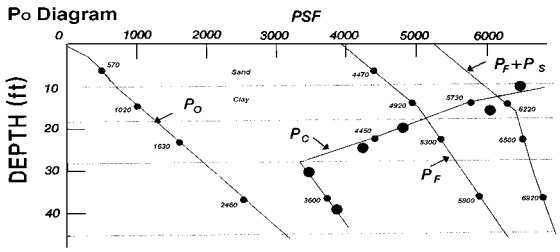
Slide 6-2-24

SOILS AND FOUNDATIONS WORKSHOP

Apple Freeway Design Problem

East Approach Embankment Surcharge

Assume:
10' high compacted surcharge (γ = 130 pcf)
Δ P of emb. (P_F) + surch. (P_S) = 5200 psf



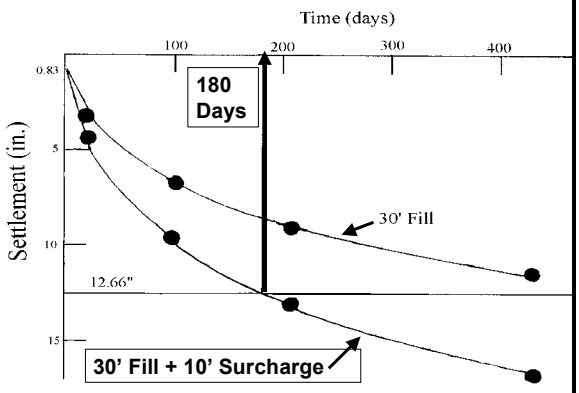
Slide 6-2-25

SOILS AND FOUNDATIONS WORKSHOP

Apple Freeway Design Problem

East Approach Embankment Surcharge

Time - Settlement Plot

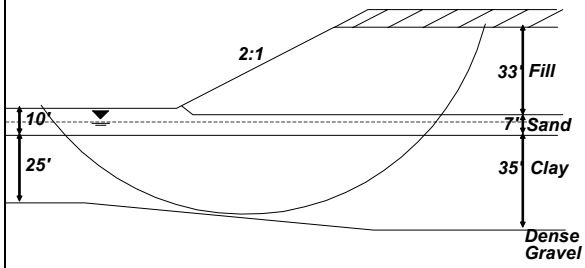


Slide 6-2-26

SOILS AND FOUNDATIONS WORKSHOP

WORKSHOP DESIGN PROBLEM
APPLE FREEWAY - E. APPROACH EMB.

Recheck stability of 30' Fill With 10' Surcharge
F.S.$_{Bishop}$= 1.33



F.S. w/surcharge = 1.33 (1.63 w/o surcharge)

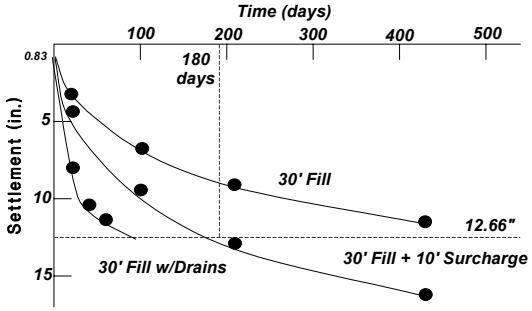
Slide 6-2-27

SOILS AND FOUNDATIONS WORKSHOP

Apple Freeway Design Problem

East Approach Embankment Settlement

Time - Settlement Plot



Treatment	***t_{90} (mo.)***	***Extra Cost***
Fill only	***14***	***-***
Fill w/10' surcharge	***6***	***$120,000***
fill w/ wick drain	***2***	***$172,000***
Fill w/sand drain	***2***	***$385,000***

Slide 6-2-28

SOILS AND FOUNDATIONS WORKSHOP

Apple Freeway Problem
East Approach Embankment Settlement

Lateral Squeeze of Clay

Remember: $\gamma_{Fill} \times H_{Fill} > 3 \times$ ***Cohesion***

3900 psf > 3300 psf

-> Can get lateral squeeze of clay

"Rule of Thumb"

Horizontal abutment movement:

= 0.25 x Fill Settlement

= (0.25)(11.8) = 3"

-> Recommend waiting period at abutment to remove settlement and prevent horizontal movement of abutments.

Slide 6-2-29

SOILS AND FOUNDATIONS WORKSHOP

Approach Embankment Settlement

Design Soil Profile

Soil layer consolidation properties selected

Settlement

32" settlement predicted
Recommend organic excavation
Rec. waiting period @ abut.

Time-Rate

433 days for t_{90}

Surcharge

10' surcharge improves t_{90} ***to 190 days***
Cost $120,000, F.S. = 1.33 O.K.

Vertical Drains

60 days for t_{90}
Cost $172,000 -> $385,000

Slide 6-2-30

SOILS AND FOUNDATIONS WORKSHOP

TREATMENT FOR EMBANKMENT SETTLEMENT PROBLEMS

1. Propose Solutions to Embankment Settlement Problems

ACTIVITIES: ***Question -Answer***

Slide 6-2-31