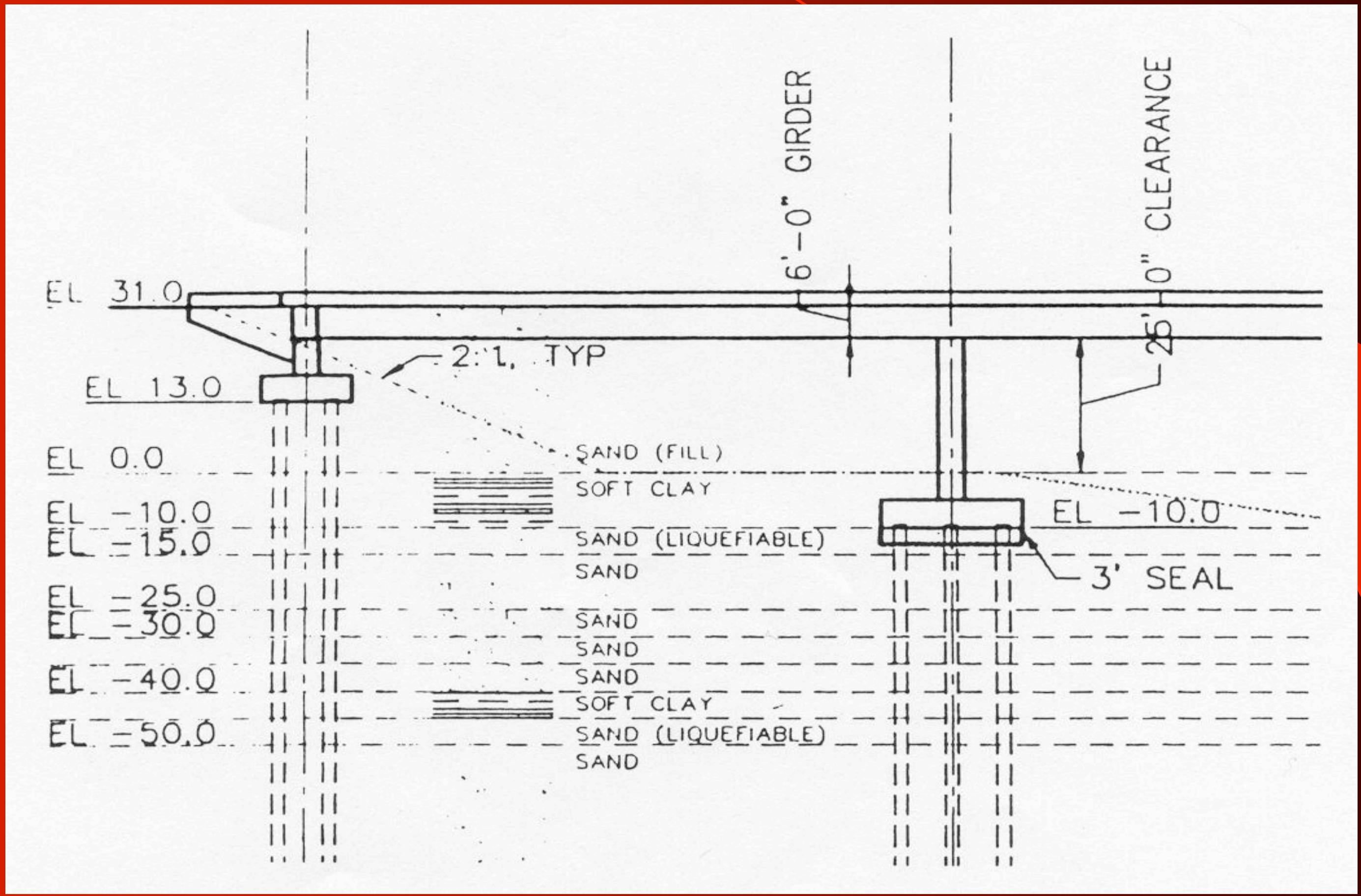
Representative Lateral Spread Problem



- Uncoupled Displacement Demand from Inertial Loading
- Stability - Conventional Limit Equilibrium Analyses using
- Residual Undrained Strengths for Liquefiable Sands

Case Histories

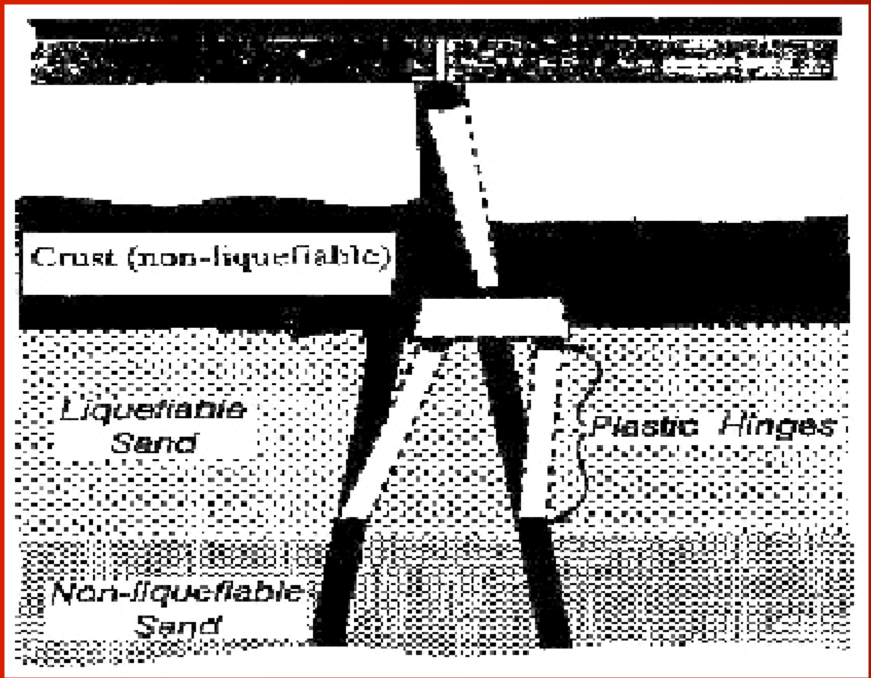


Figure 1: Landing Road Bridge Lateral Spread

(after Berrill et al., 1997)

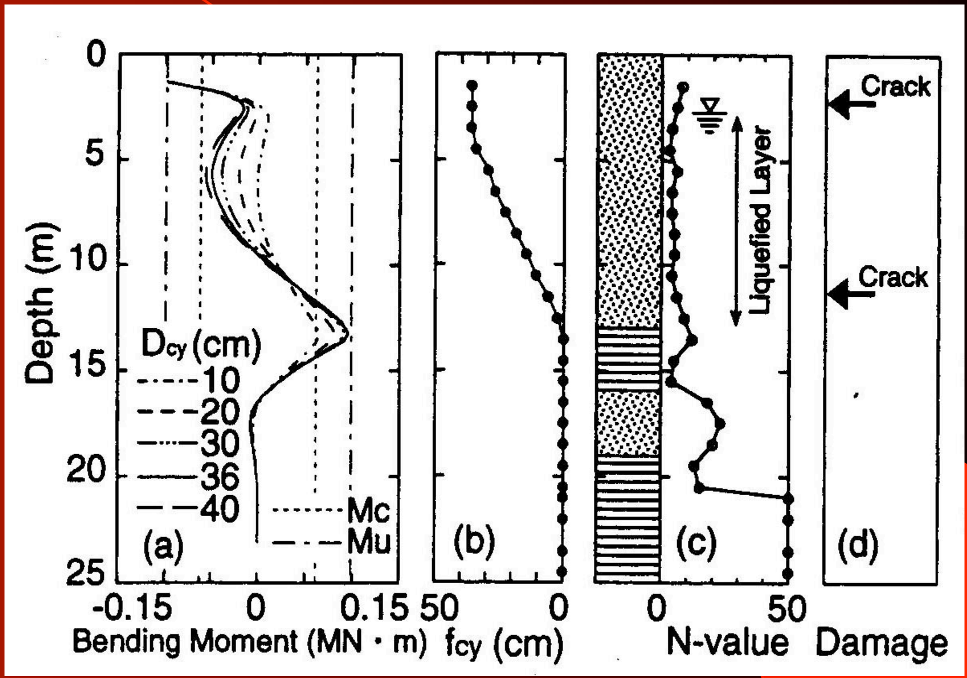
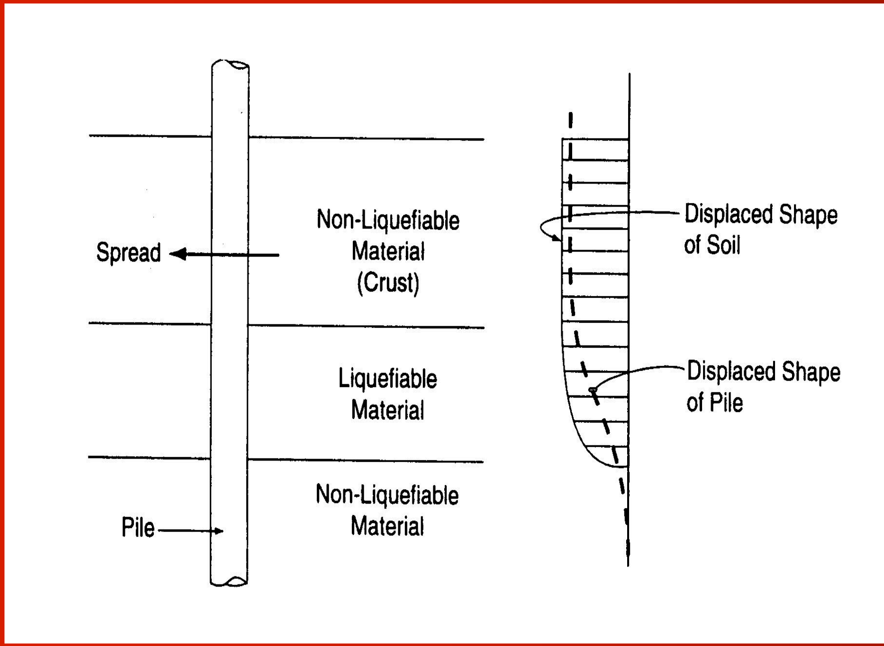
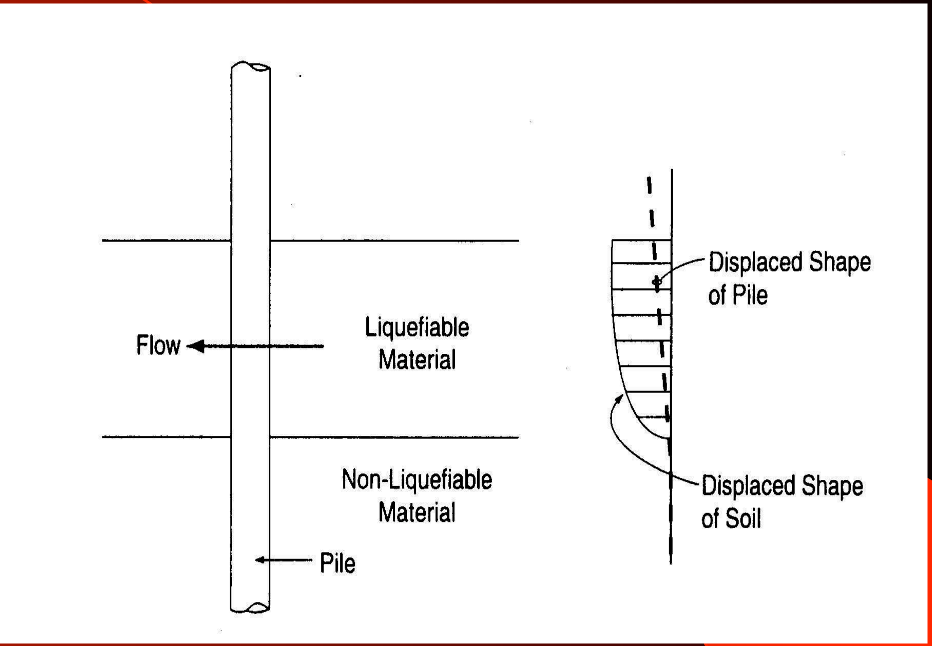


Figure 2: Site and Damage Characteristics for a Precast Concrete Pile Subjected to a Lateral Spread in the Kobe Earthquake (after Tokimatsu and Asaka, 1998)

Pile Deformation Modes





a) Pile Moves with Soil Crust

b) Pile in Limiting Equilibrium State under Passive Pressure

Liquefaction Design Approaches

- **Two configurations for inertial load design:**
  - **Nonliquefied configuration – design using site soil spectrum**
  - **Liquefied configuration – Softened foundation stiffness in liquefied layer and same site soil spectrum unless special studies undertaken**
- **Two options for flow slides or lateral spread conditions:**
  - **Pile design to resist lateral forces or displacement demands**
  - **Ground mitigation measures**

Design Approach Summary

- **Identify Potential Liquefiable Soil Strata**
- **Check for Flow Slide Potential (FOS < 1)**
- **Determine Lateral Spread Displacements (FOS > 1) using Newmark Method**
- **Evaluate Pile/Soil Interaction Mechanism**
- **Evaluate Pile Pinning Effects**
- **Evaluate Mitigation Options if Needed**
  - **Ground Improvement**
  - **Pin Piles**

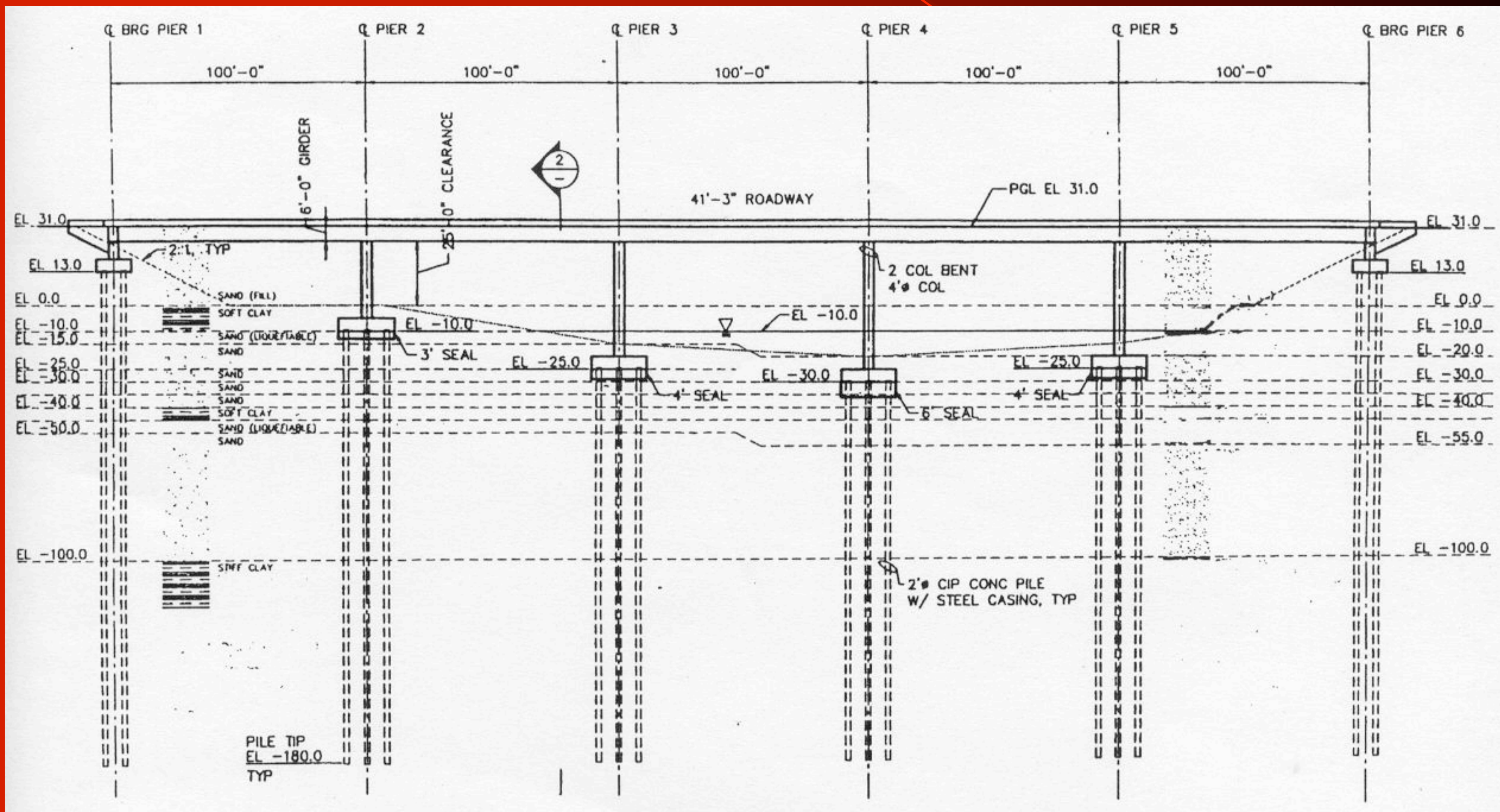
Recommended LRFD Guidelines for the Seismic Design of Bridges, 2001

Recommended Design Approach for Liquefaction Induced Lateral Spreads

Case History

Washington State Bridge

Site Profile – Washington Bridge



Typical Sliding Mechanism for Flow Failure

PCSTABL5M/si Fsmin=0.79
Safety Factors Are Calculated By The Modified Janbu Method

Forces Provided by Bridge and Foundation Piles for Resisting Lateral Spread