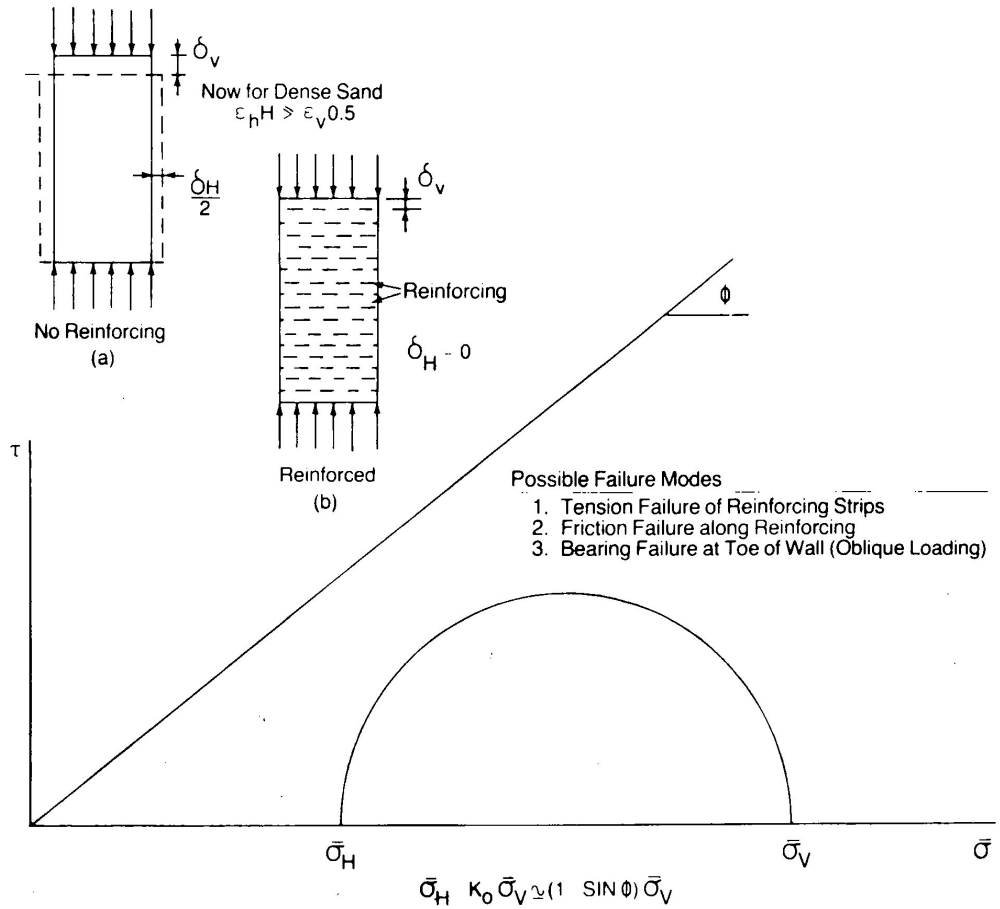
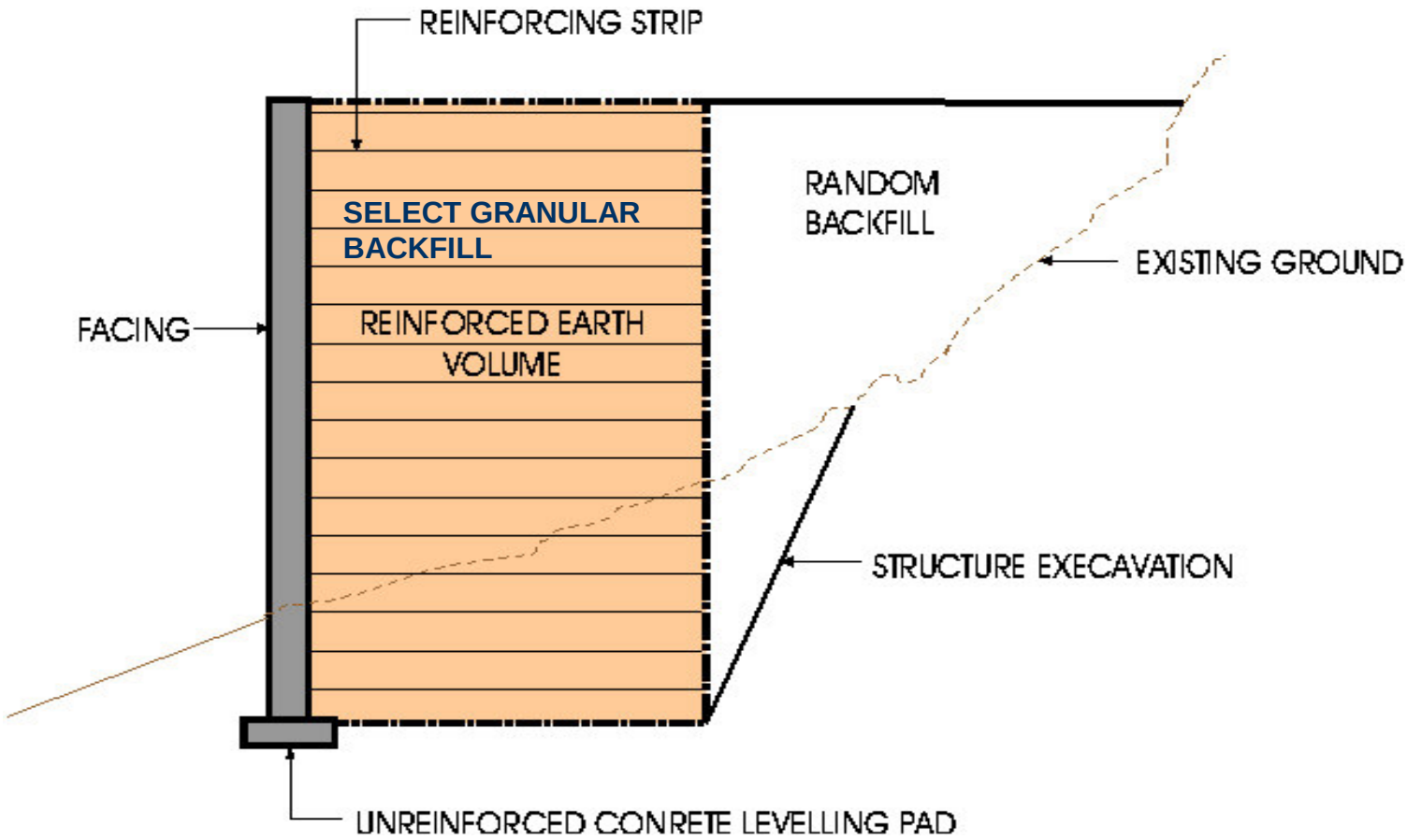
Keith P. Brabant, P.E.

Mechanically Stabilized Earth Walls For Support of Highway Bridges

Basic Mechanism of Mechanically Stabilized Earth



Components of a MSE wall



Section Thru an MSE wall

Select Granular Backfill - Soil

- Maximum of 15% fines
- Maximum size of 4 inches
- Free-draining, frictional, and durable
- Graduation limits referenced by AASHTO T-27

US Sieve Size	% Passing
4”	100
40	0-60
200	0-15

Soil Reinforcement

- Inextensible – steel
  - Definition: does not stretch considerably
  - Forms:
    - Ribbed steel strips
    - Welded wire bar mats
    - Welded wire ladders
  - Used in all mechanically stabilized earth applications
- Extensible – plastic
  - Definition: stretches so reinforcement strain >= soil mass strain
  - Forms:
    - Uniaxial and biaxial geogrids
    - Woven and non-woven geotextiles
  - Used in reinforced slopes, basal reinforcement, temporary wrapped geotextile faced walls, and blockwalls. Applications in which significant horizontal deformations are tolerable.

Facing for MSE structures

- Permanent Bridge Structures
  - Precast concrete

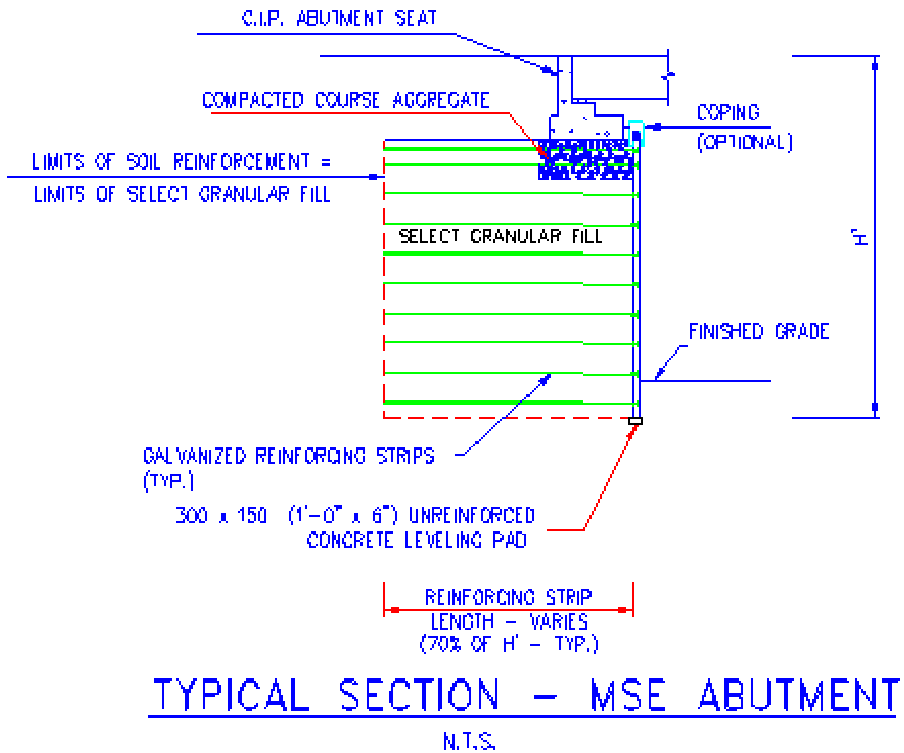
Non Critical Structures

- Precast Concrete
- Dry-cast concrete block
- Welded wire fabric or geotextile

Bridge Abutments and MSE walls

- MSE Abutment = where the bridge beams are supported on spread footing, which is directly supported by the MSE mass
- Mixed Abutment = a pile supported abutment with MSE walls providing support of the fill.
- Either type may be an "Integral" abutment.

MSE Abutments



Benefits of MSE abutments

- Lower costs
- Elimination of piles
- Less cast in place concrete
- More flexible wall system
  - Better seismic performance than traditional abutments
  - Excellent performance on soft soils
  - Ability to withstand post construction settlements

- Eliminates the "Bump Behind the Bridge"
  - Abutment settles with approach fill

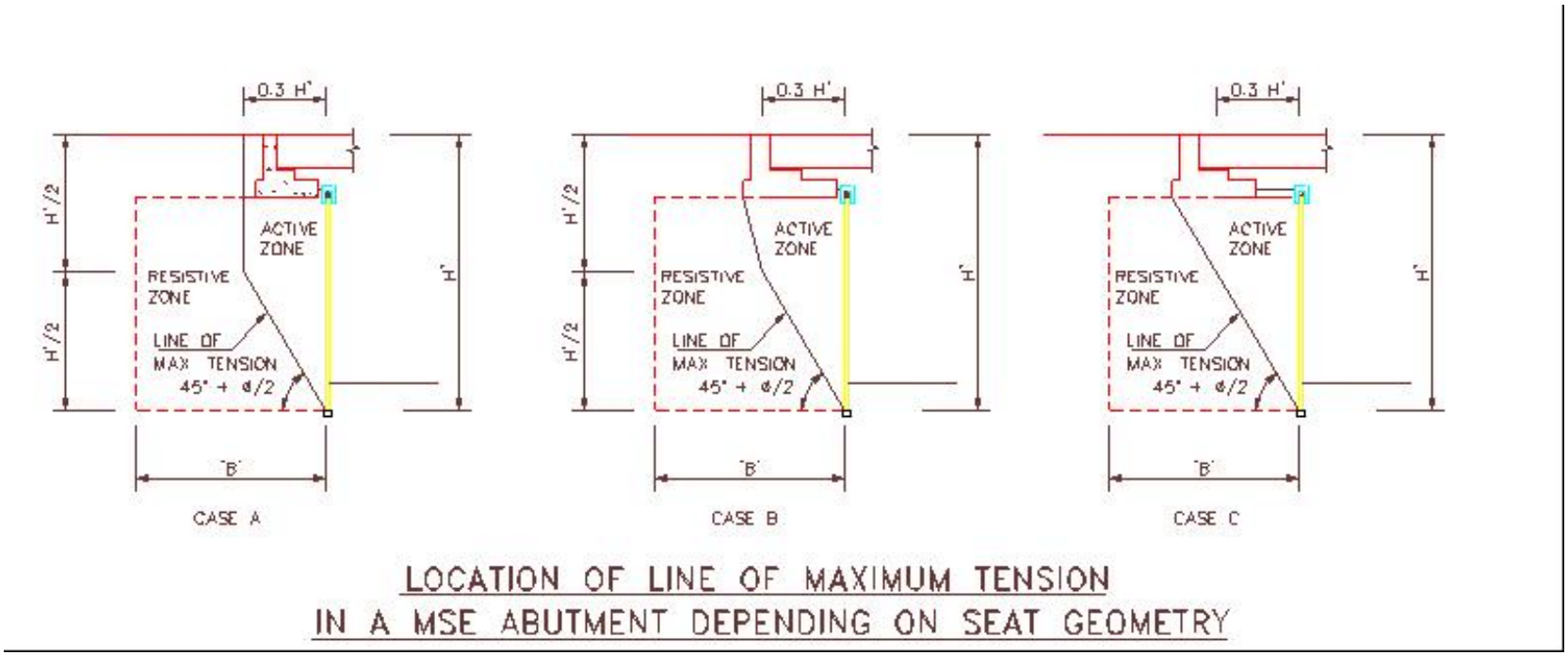
Historical Use of MSE abutments

- The first mechanically stabilized earth (MSE) bridge abutment was constructed in Strasbourg, France in 1969 with Reinforced Earth®. The first U.S. MSE bridge abutment was constructed in Lovelock, Nevada in 1975 with Reinforced Earth®. Since 1975, over 220 MSE abutments have been constructed in the United States with Reinforced Earth technology. Other companies such as VSL and The Neel Co. have also constructed MSE abutments. MSE abutments are approved for use by 20 state DOT's. In the northeast region, over 100 MSE abutments have been constructed in Connecticut, Maine, Massachusetts, New Hampshire, New York and Vermont.

Seismic Performance

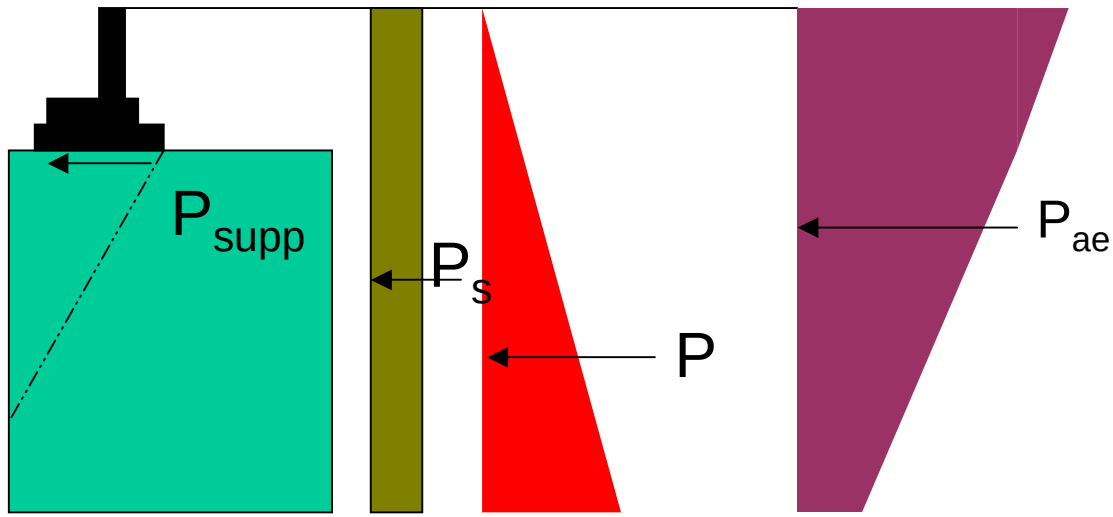
- Liege, Belgium, 1983. Three abutments and several high retaining walls (up to 17m) were within 3.5 km of the epicenter of a Richter Magnitude 5.0 earthquake. None of these structures showed any damage or deformation.
- Bay of Plenty, New Zealand, 1987. Two Reinforced Earth abutments were nearing completion in Maniatutu, 30km from the epicenter of a Richter magnitude 6.3 earthquake. The structures performed perfectly during the earthquake and construction was completed with no remedial action required.
- Northridge, California, 1994. Twenty-one Reinforced Earth Walls and two Reinforced Earth bridge abutments were subjected to this Richter magnitude 6.7 earthquake in the densely populated San Fernando Valley, 20 miles northwest of downtown Los Angeles. Sever damage occurred to buildings, bridges, and freeways. All of the Reinforced Earth Structures performed extremely well, with only superficial damage to a few facing panels of one wall.

Design Considerations – MSE Abutments



LOCATION OF LINE OF MAXIMUM TENSION
IN A MSE ABUTMENT DEPENDING ON SEAT GEOMETRY

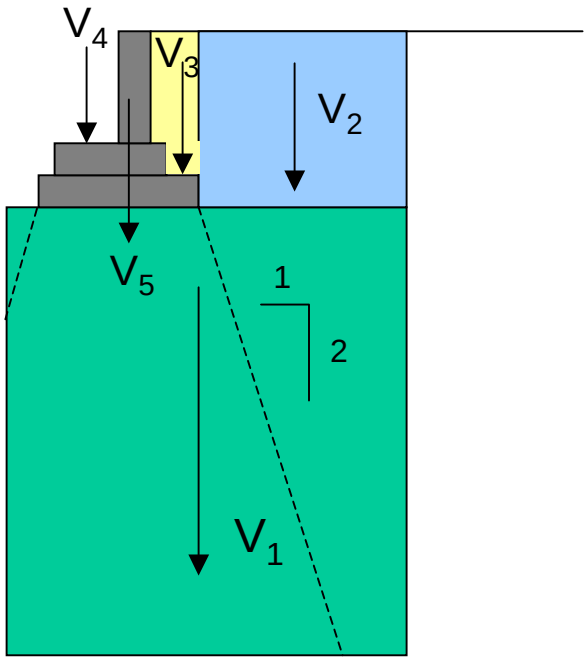
Horizontal Loads



P_{supp} = Supplemental Horizontal load from bridge. P_s= Surcharge

P = Earth Pressure P_{ae} = Seismic Earth Pressure

Vertical Loads



V_1 = Weight of reinforced zone

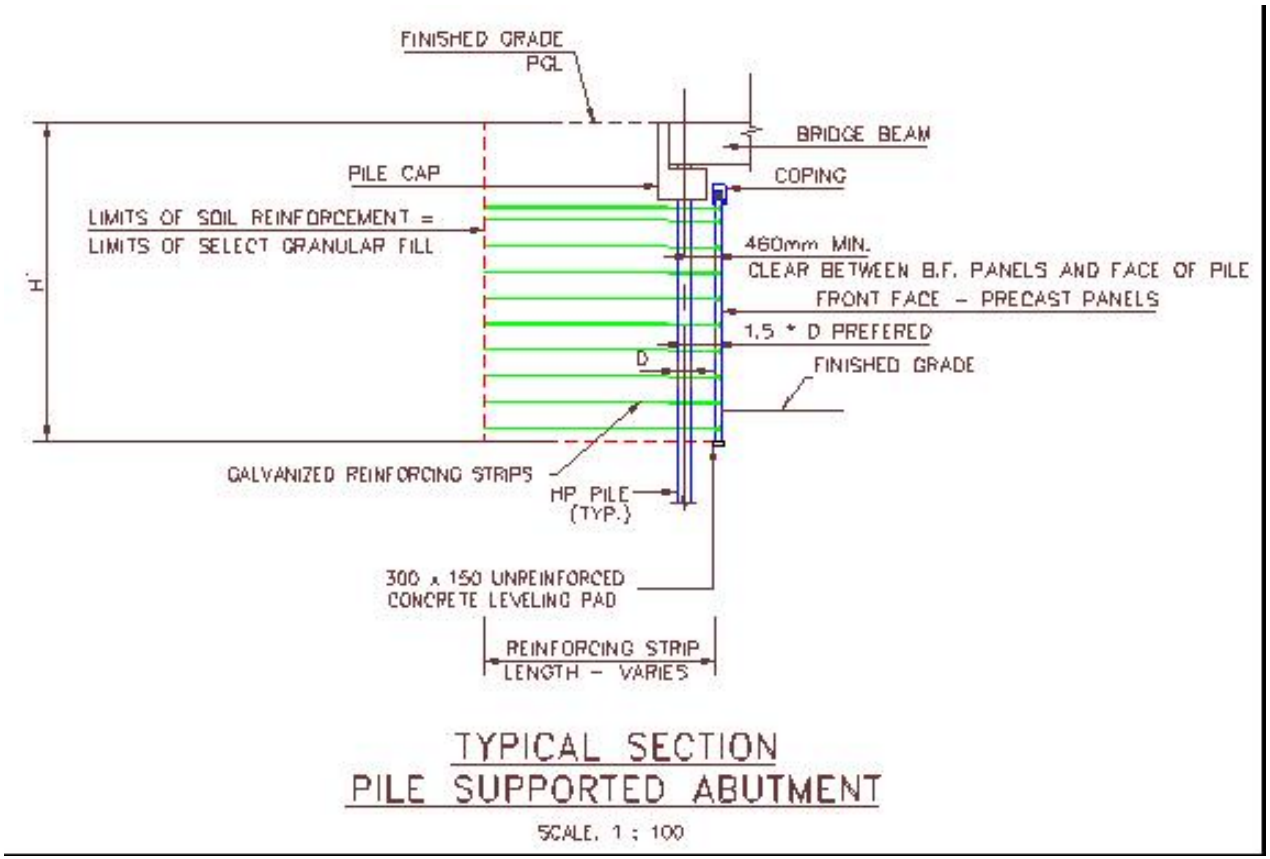
V_2 = Weight of retained zone

V_3 = Weight of soil above toe

V_4 = D.L. + L.L. of Bridge

V_5 = Weight of abutment seat

Pile Supported Abutments



Conclusions

- MSE Abutment walls with Precast Concrete facings and Galvanized Steel reinforcements are:

  -Economical

  -Flexible: Tolerate Settlement

  Stable in Seismic Events

- Pile Supported MSE abutments may be used in applications where a MSE abutment on spread footings is not feasible:

  - Significant Differential Settlement (Along Wall or Bridge alignment)
  - When bridge loads are high enough that a pile supported abutment is more economical than a large spread footing.