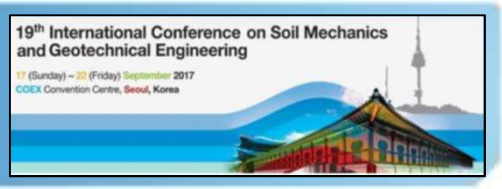
TC211-218 Workshop
MSE Walls and Reinforced Fills

Overview of MSE Walls & Combined Anchor Systems

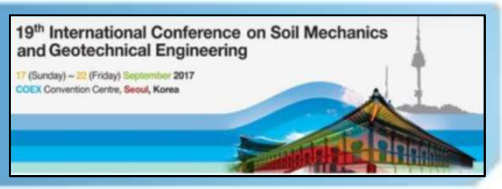
John Sankey, Terre Armeé

Outline of Presentation



I. Introduction to Mechanically Stabilized Earth
II. Components & Wall Types
III. Basic Rules of the Practice
IV. Applications
V. Combined Anchor Systems
VI. Conclusions

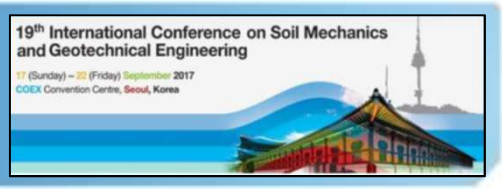
Introduction



Mechanically Stabilized Earth (MSE)
Seen Widely Along Highways But Not Always Recognized

France - A 40 Motorway

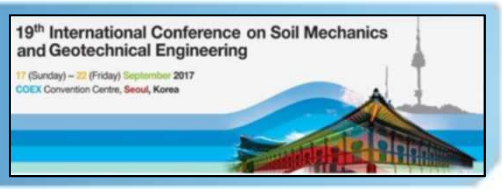
History



Invented by Henri Vidal (1924-2007)

French Architect

History

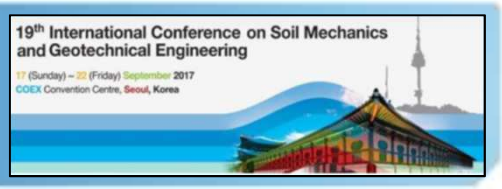


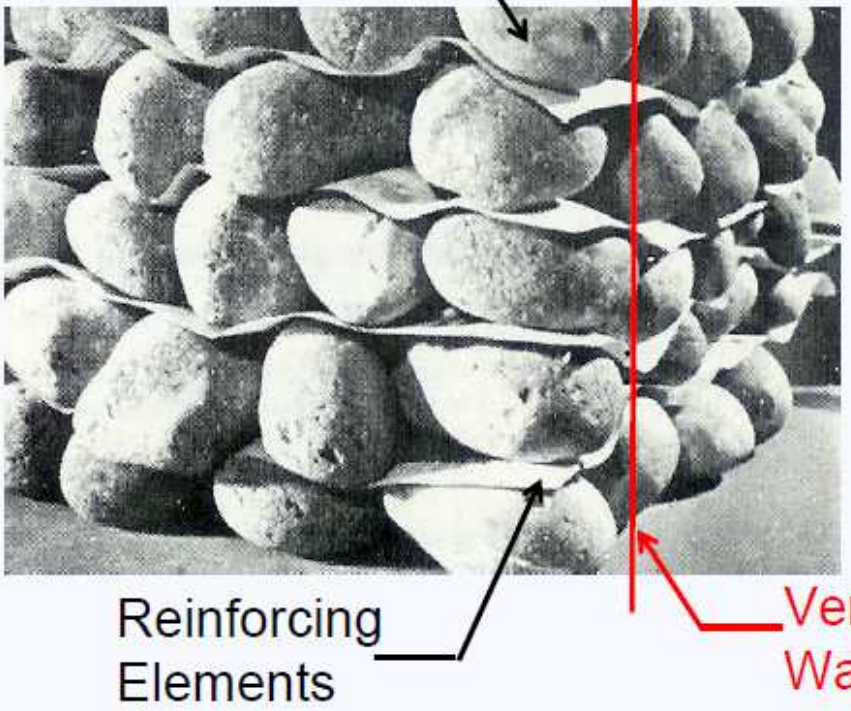
Legend is - On a beach in Ibiza Spain Henri was reinforcing sand with pine needles to build sand castles

And thus developed the idea of the MSE Wall Technology

MSE Walls have been Recognized as a major innovation in civil engineering

Principles

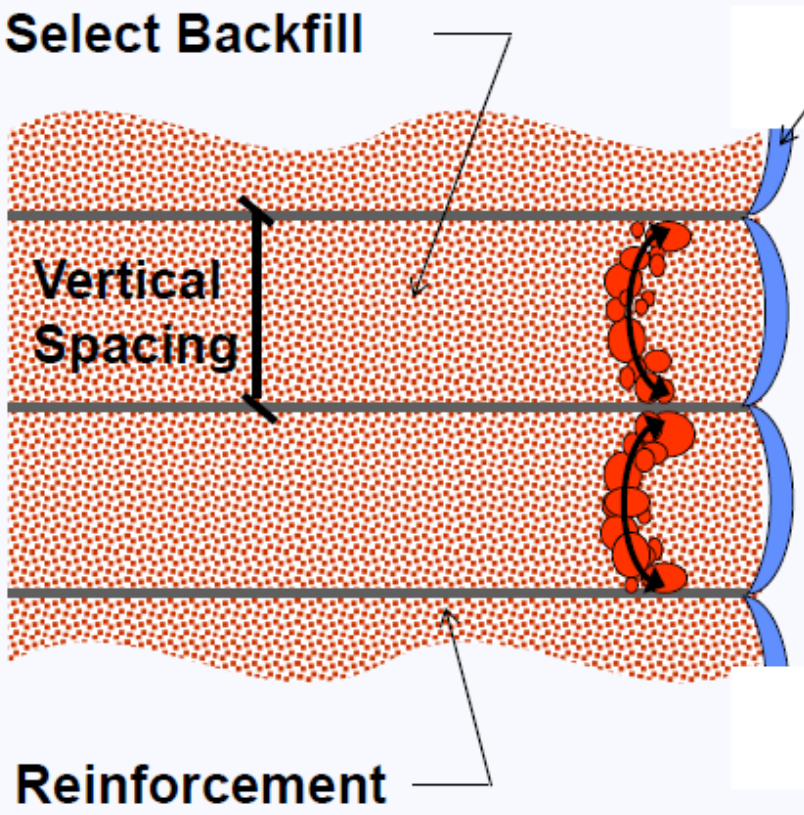




- Friction between the Backfill and Reinforcing Elements creates artificial cohesion (Composite Material).
- Tensile strength of Reinforcing Elements allows to build a vertical wall.
- This Basic principle can be called the main structural support of the MSE wall.

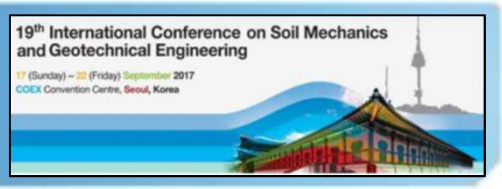
Select backfill combined with the Reinforcing Element

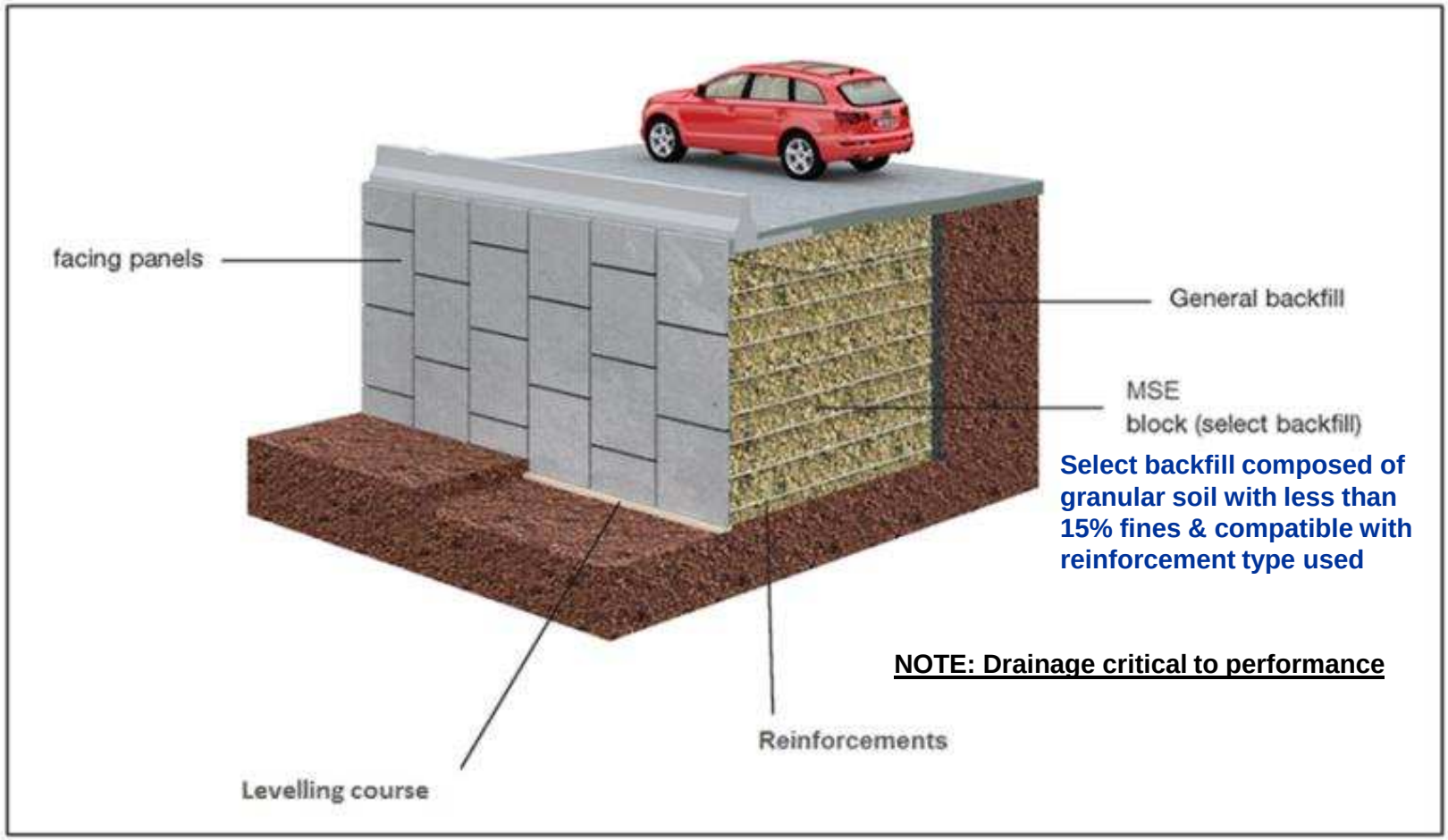
Principles



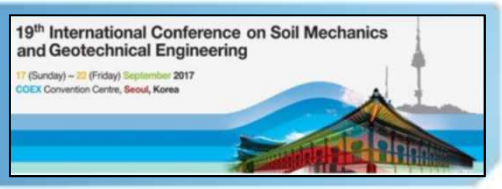
- The Facing Panel is required to Connect to the Reinforcing Elements
- The Facing Panel provides local stability of the select backfill between reinforcing elements and protects against erosion.
- The Facing Panel is considered a secondary structural element of the MSE wall.

Basic Components



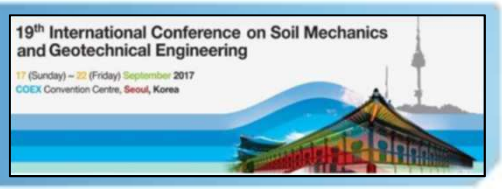


Sizing Up MSE Industry



- **Approximately 25% to 50% savings over conventional reinforced concrete retaining walls**
- **Internationally, approximately 18 million ft^2 of MSE wall built annually (largest user is USA)**
- **Breakdown of relative costs (FHWA):**
  - 20% to 30% Erection Costs and Contractor Profit
  - 15% to 40% Facing Costs
  - 30% to 60% Backfill Costs
  - Add On for Top Outs & Any Unusual Foundation Conditions

Flexibility of MSE Walls



Main Physical Advantage

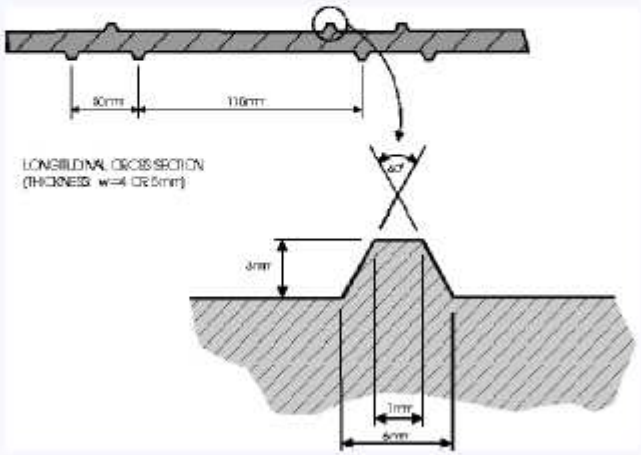
Total settlement is not a problem

However, differential Settlement is limited by the Joint Width between facing elements

Joint Width	Limiting Differential Settlements
¾"	1/100 *
½"	1/200
¼"	1/300

*When significant differential settlements are anticipated (greater than 1/100) slip joints must be provided.

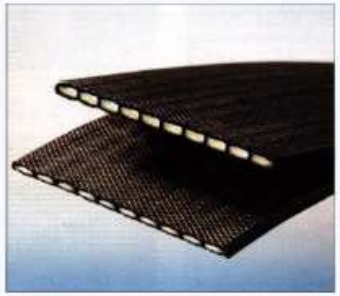
Types of MSE Walls



Concrete Facing with Metallic Strips

Types of MSE Walls

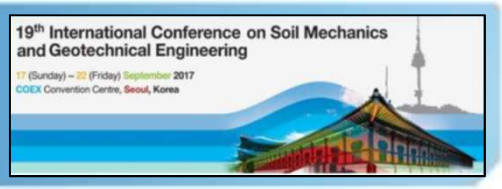
Concrete Facing with Geosynthetic Strips or Grids

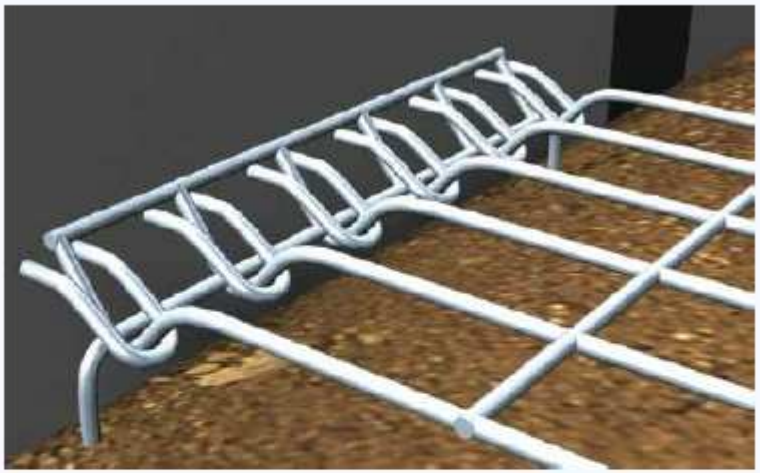


High-tenacity polyester yarns protected by polyethylene sheath

Geogrids

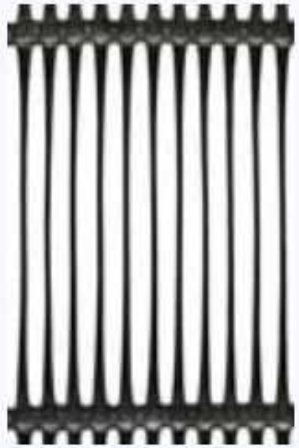
Types of MSE Walls





Concrete Facing with Metallic Mesh or Ladders

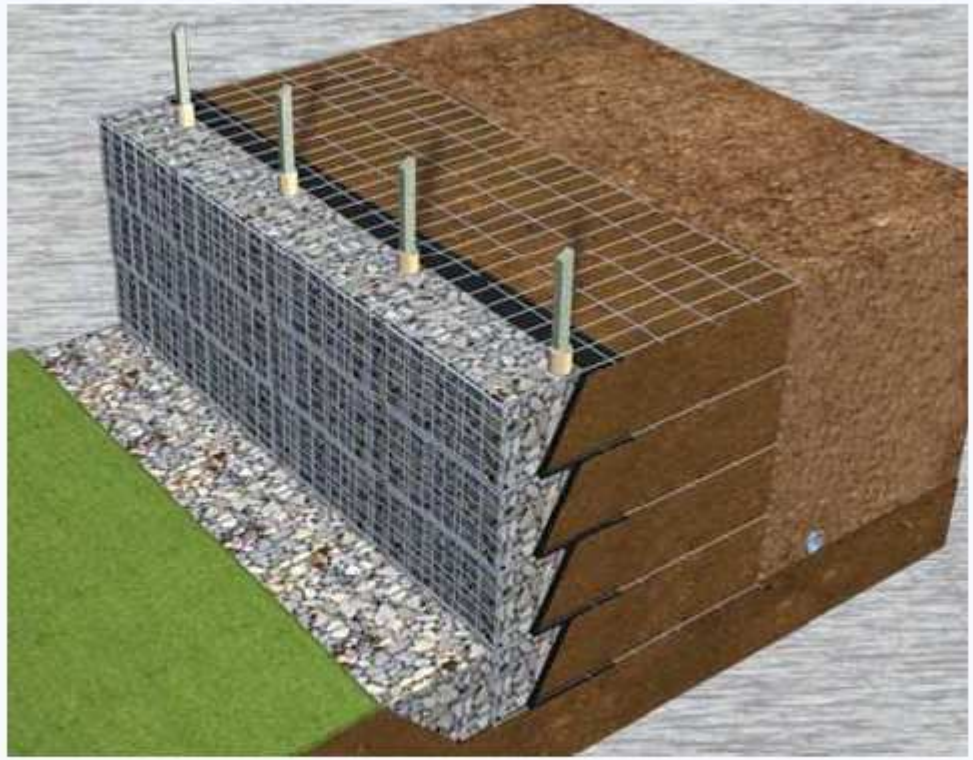
Types of MSE Walls



Concrete Block Facing with GeoGrid Mesh

(Also Metallic Ladders & Grids; Less Prevalent)

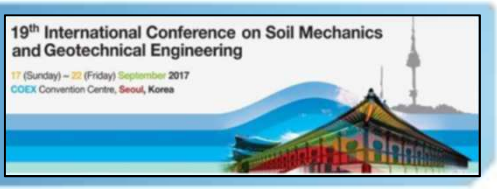
Types of MSE Walls

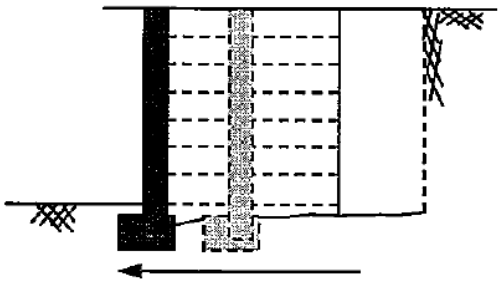


Wire Facing Either GeoGrid or Steel Reinforcement

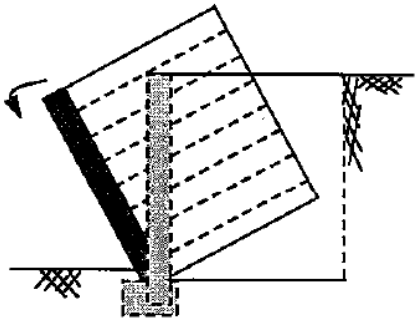
(ALSO WRAP AROUND GEOTEXTILE FACING)

Design – External Stability

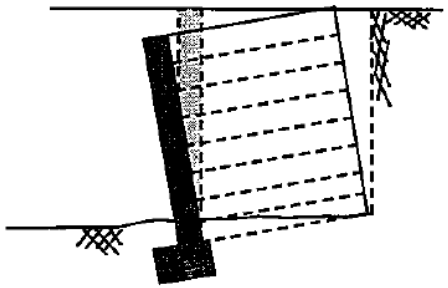




Sliding



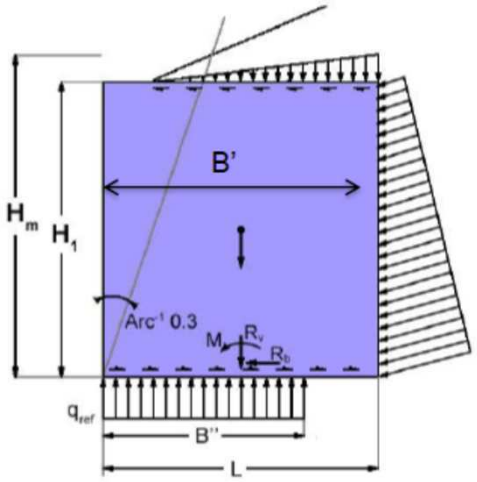
Limiting Eccentricity



Bearing

Also Global Stability Requirements

Design – Internal Stability



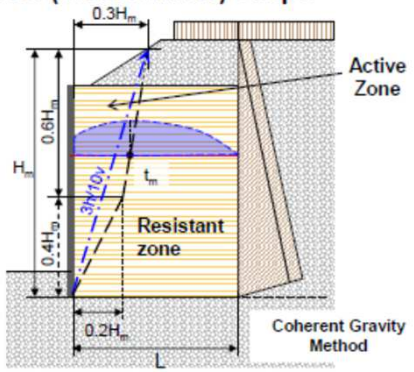
Meyerhof Method

$B'' = B' - 2(M/R_v)$

$Q_{ref} = R_v / B''$

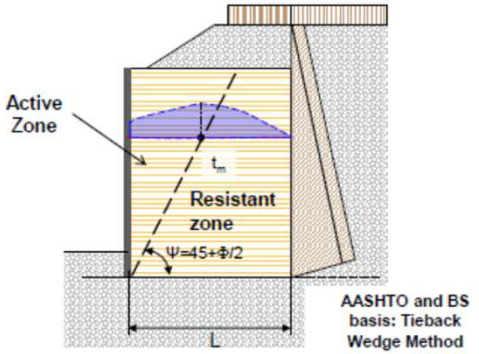
Bearing Pressure vs Bearing Capacity

Steel (Inextensible) Strips



Pullout - Active vs Resistance Zones
Rule of Thumb: L ≥ 70% H_m

Geosynthetic (Extensible) Strips



Determination of Maximum Tension (Code Dependent)

Pullout and Tensile Capacity Specific to Steel or Geosynthetic Reinforcement Used

Applications

Transportation

Roadways

Abutments
(True & Mixed)

Railways

Runways

Mines

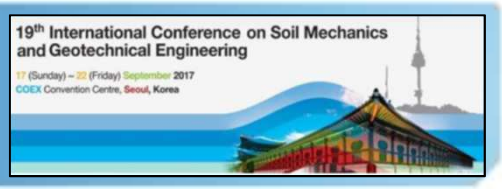
Dams & Waterways

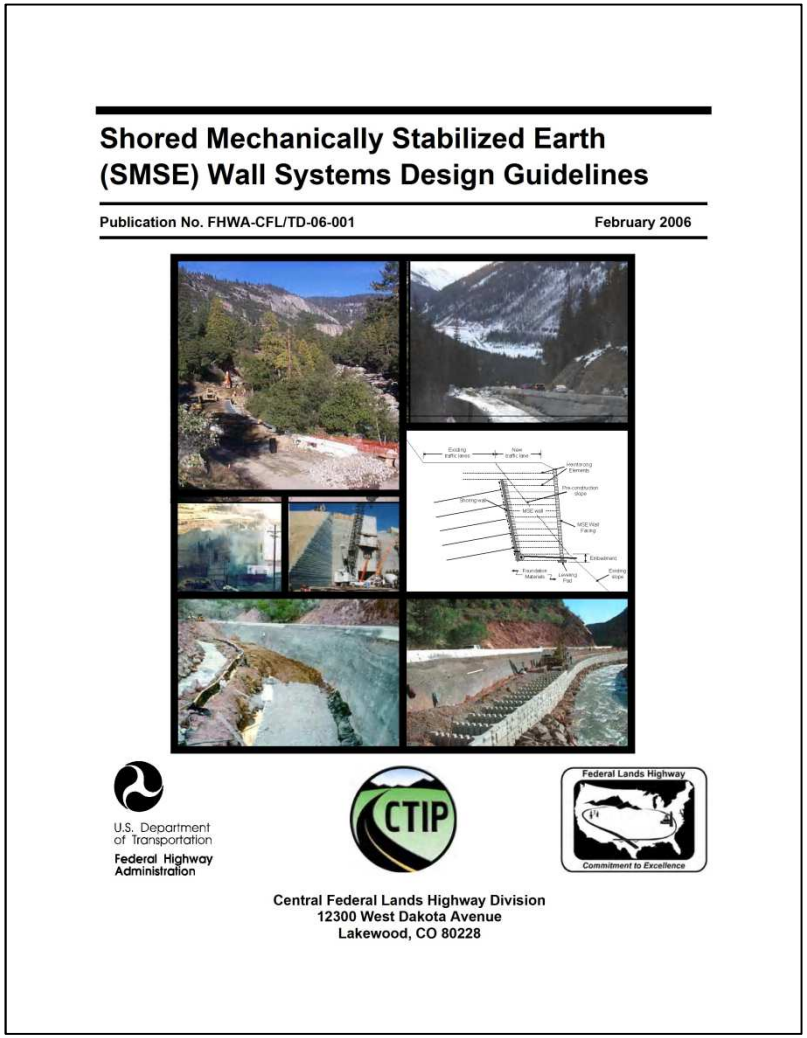
Protective

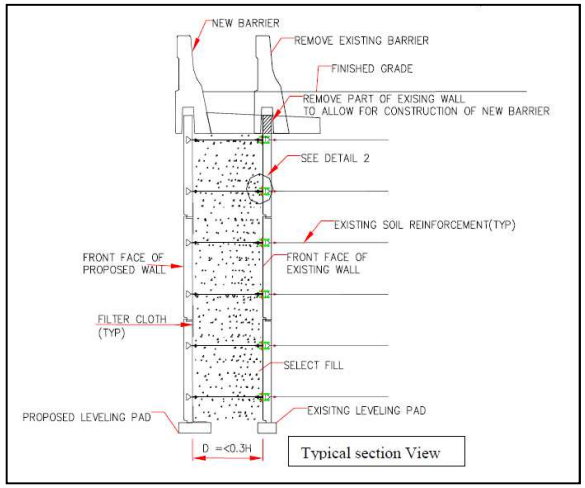
Commercial

Applications Only Limited By Imagination

Shored Reinforced Walls





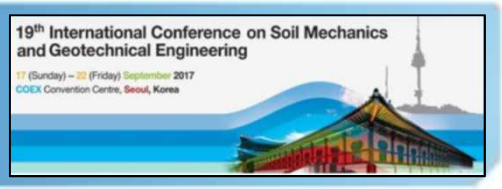


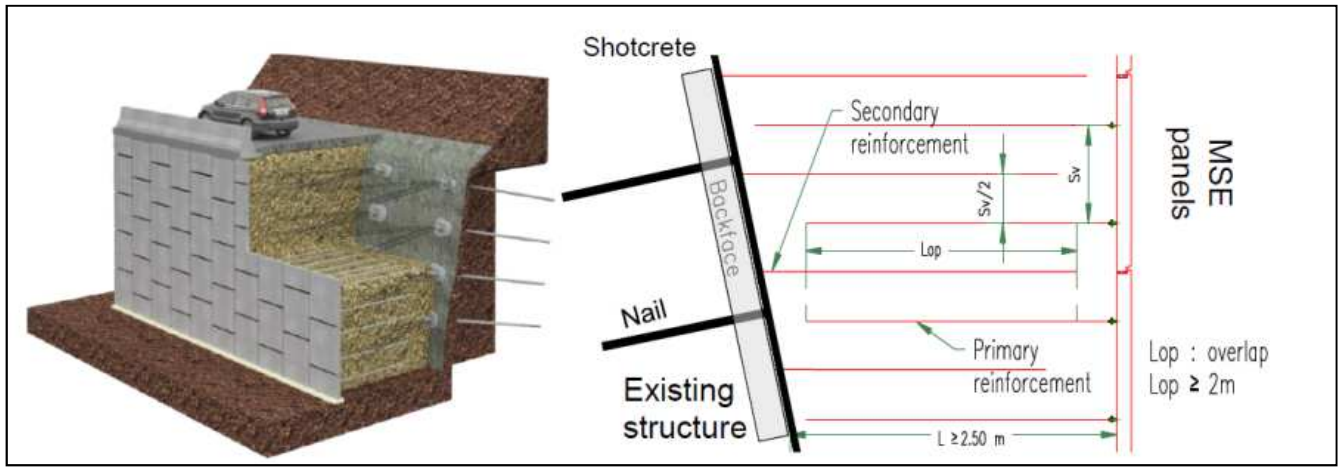
Expand Road Right-of-Way (New MSE to Old MSE Wall)

Started as Direct Connect System (Where L < 0.7 H)

New Wall Section Connected To Soil Nail or Rock Anchor

Shored Reinforced Walls





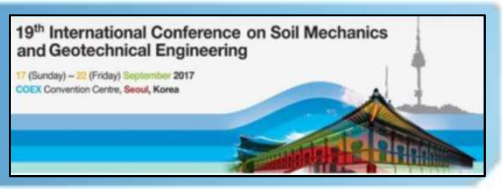
Soil Nail or Rock Anchor Most Common Application at Back Face

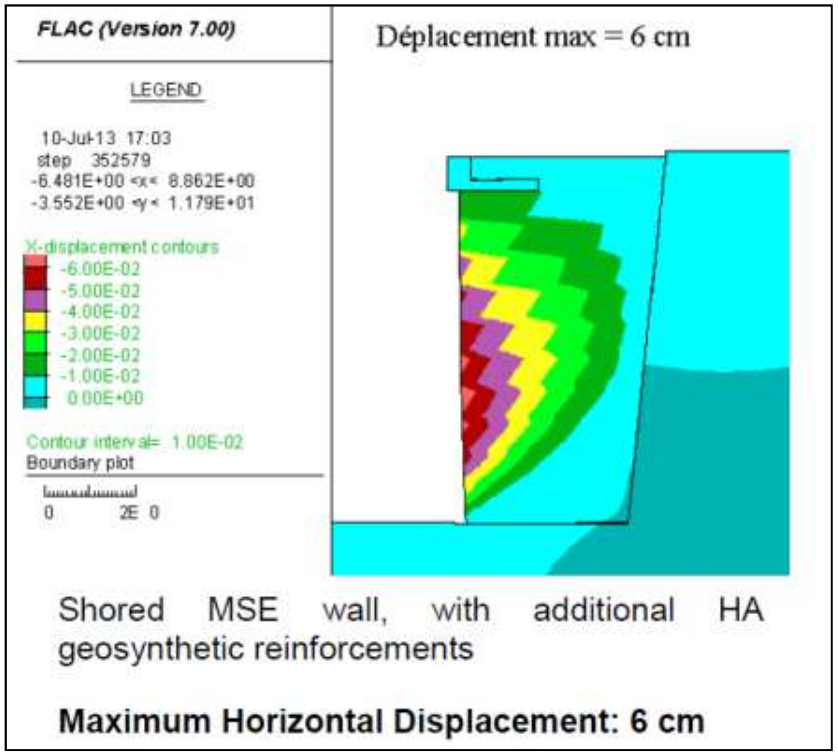
Steel Reinforcement

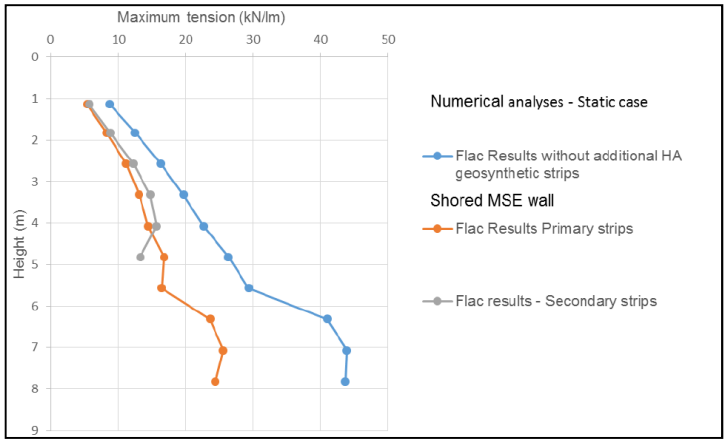
Now Overlapping Possible at 0.3H < L < 0.7H (Direct Connect Still at L< 0.3 H)

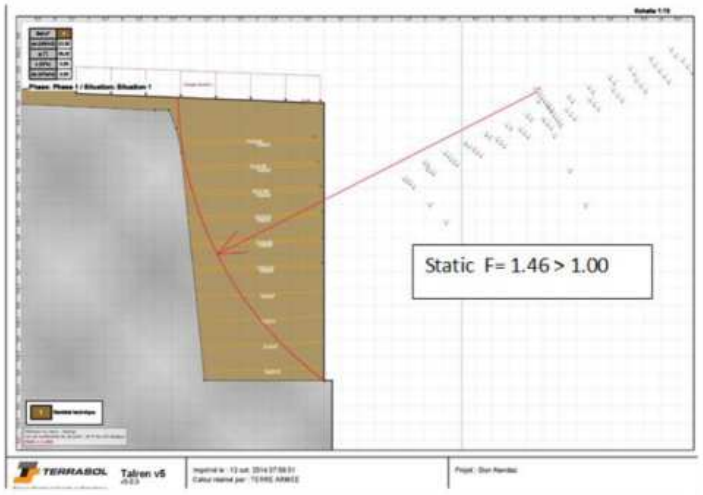
Geosynthetic Reinforcement

Shored Reinforced Walls



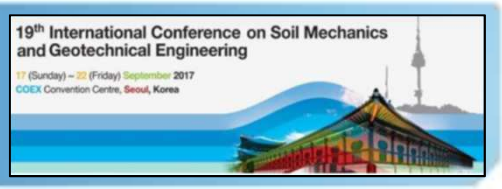






Displacement, Tension & Global Stability Models Available in Literature, e.g., GeoAmericas 2016

Conclusions



- MSE walls are versatile retaining structures for transportation and a host of other applications
- Combinations with anchor technology gives wider range of use
- Offers over 50 years of superior performance
- Cost saving technology combined with ease of construction
- Steel or geosynthetic reinforcement applications need to address material properties matched to loading and environment requirements
- Overview provided here has more detailed studies available to verify applications