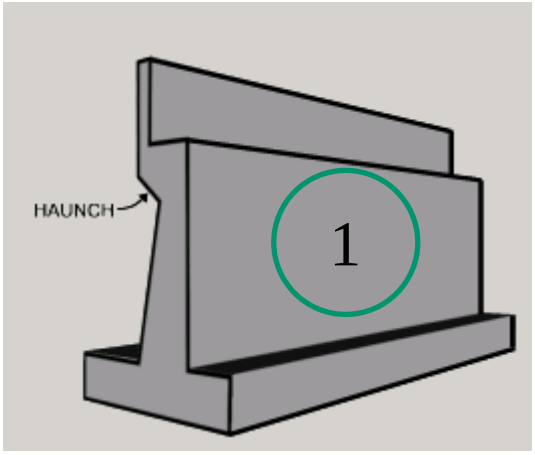
Mechanically Stabilized Earth (MSE) Wall

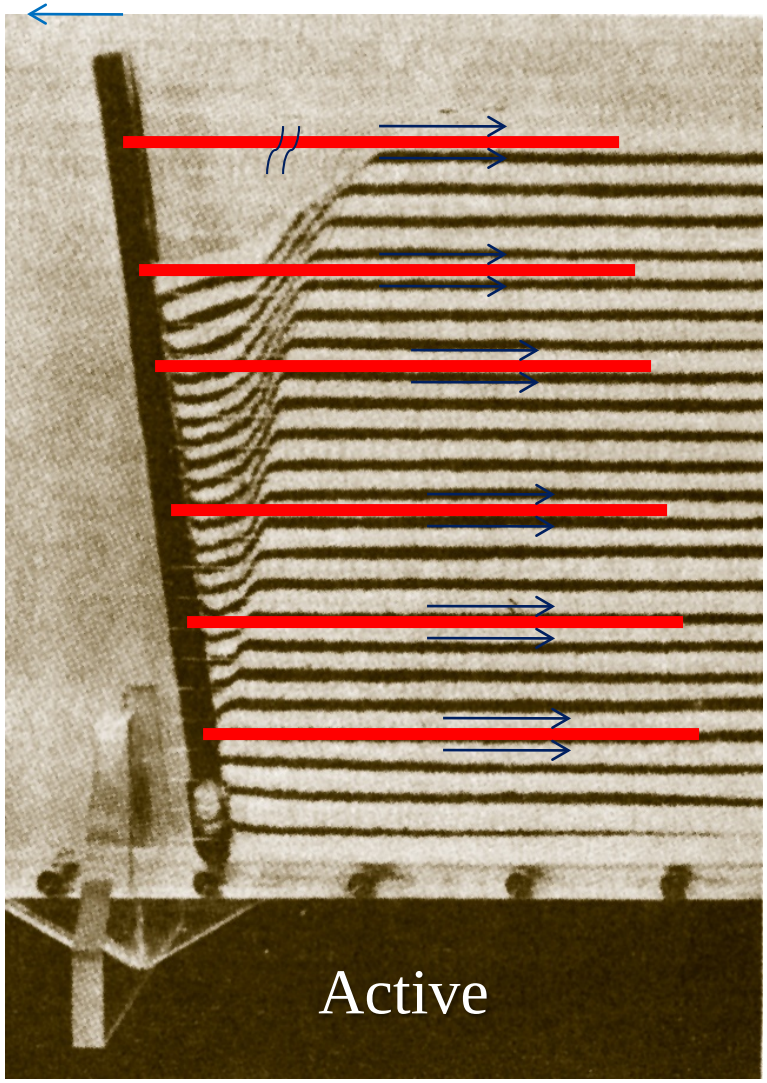
Geotechnical Design
CEG 4801

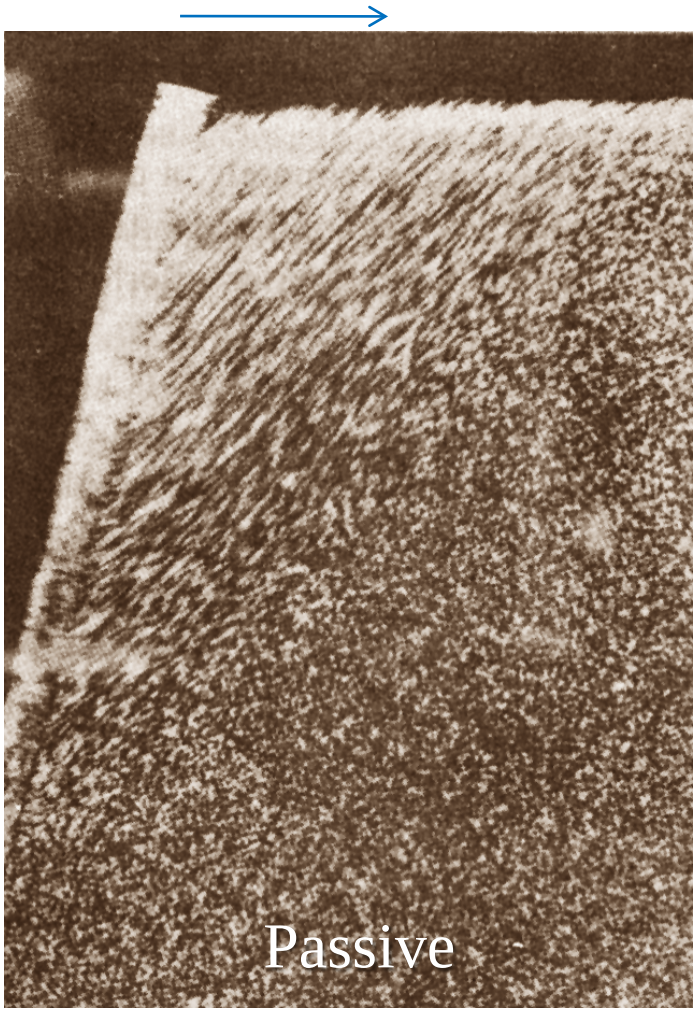
Kamal Tawfiq, Ph.D., P.E.

Choices for Bridge Abutments



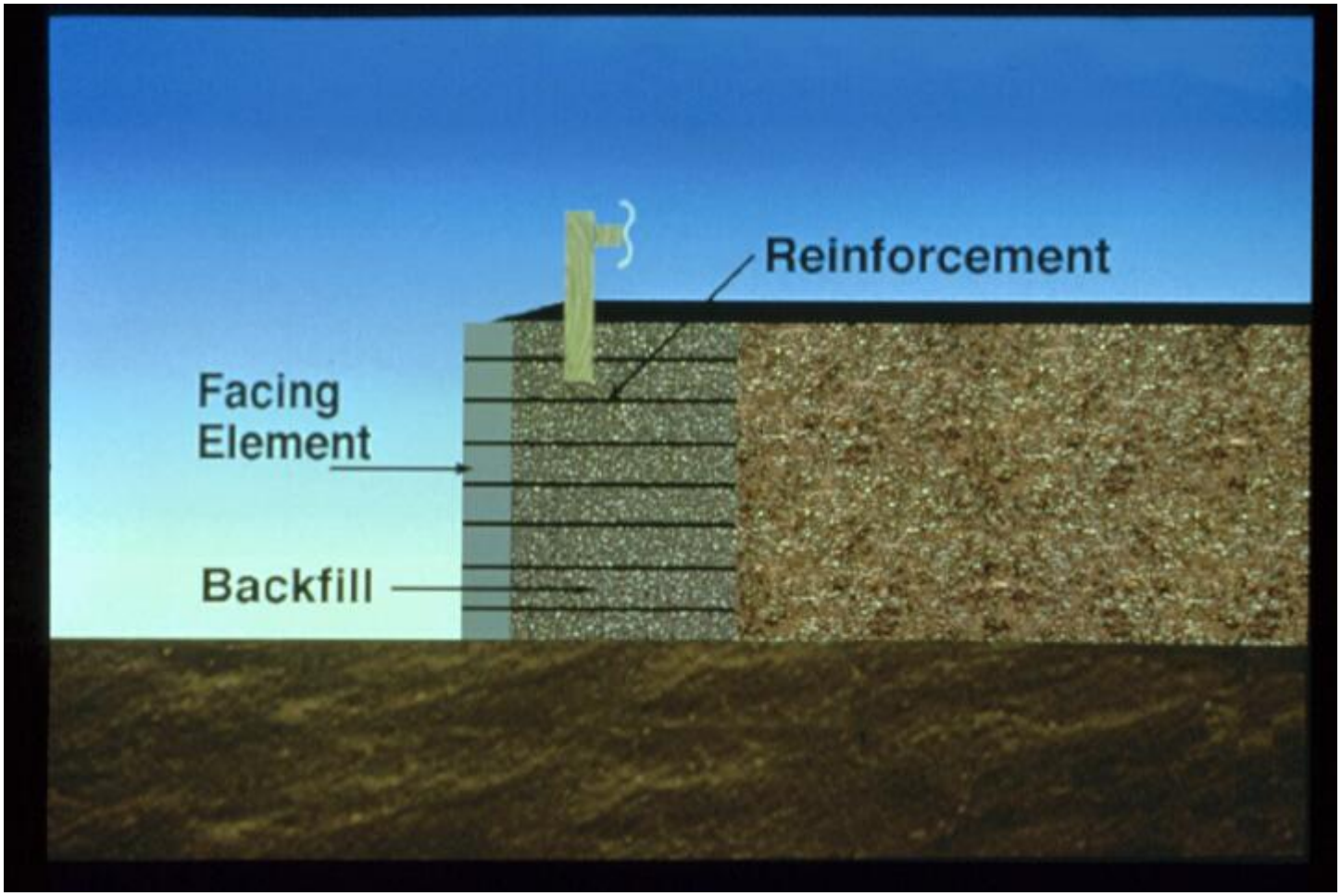
Geotechnical Design
CEG 4801
Fall 2010
By: Dr. Kamal Tawfiq



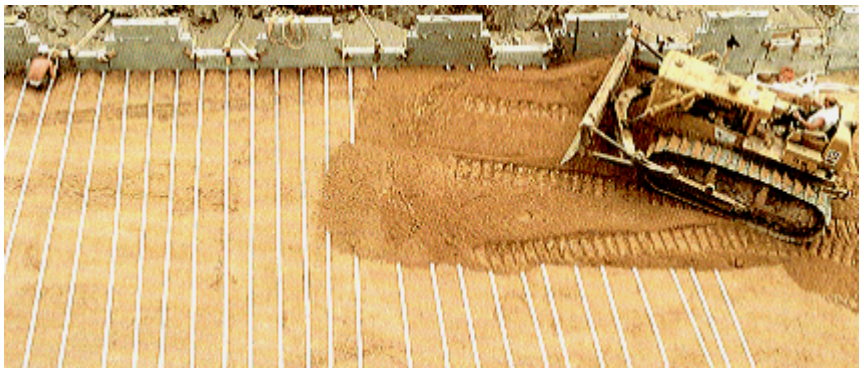


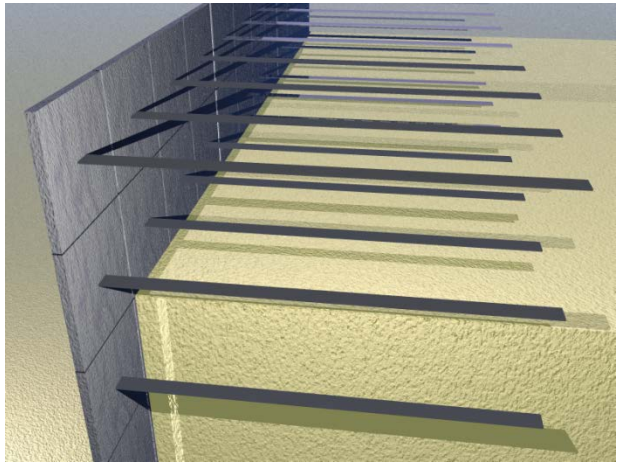
Earth Pressure Behind Retaining Wall

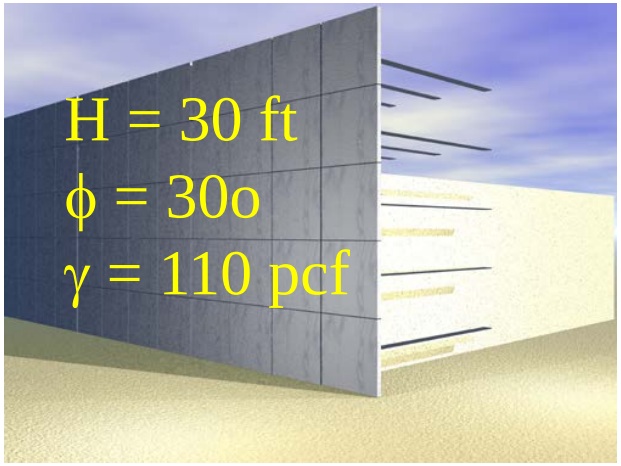
French architect and engineer
Henri **Vidal** in the early 1960s

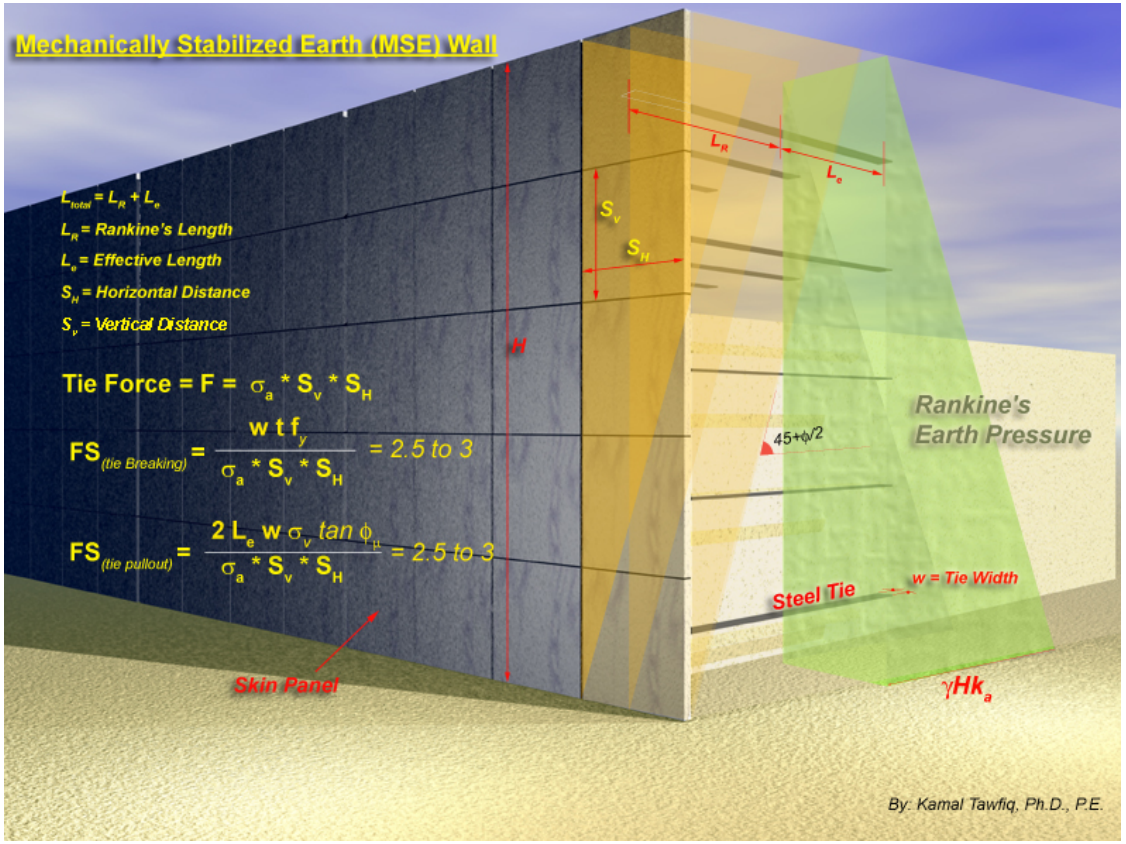

Reinforcement
Facing
Element
Backfill

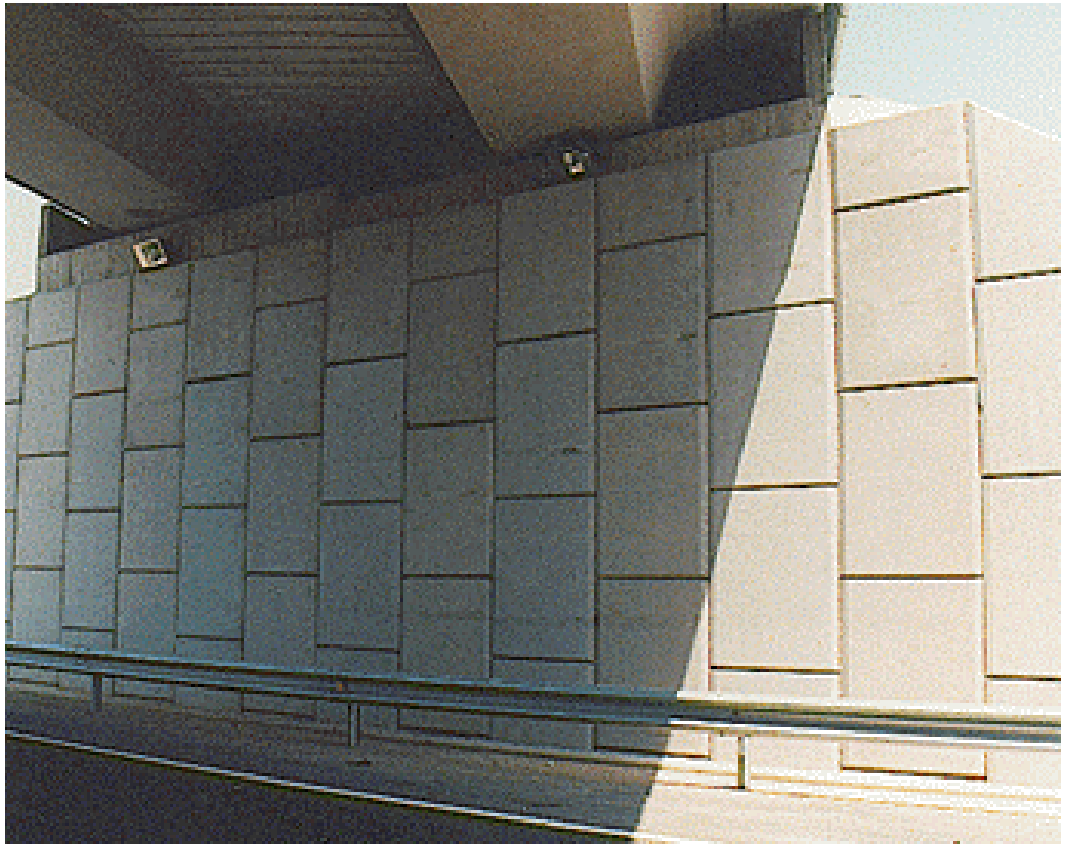
Mechanically Stabilized Earth (MSE) Walls or Segmental Walls







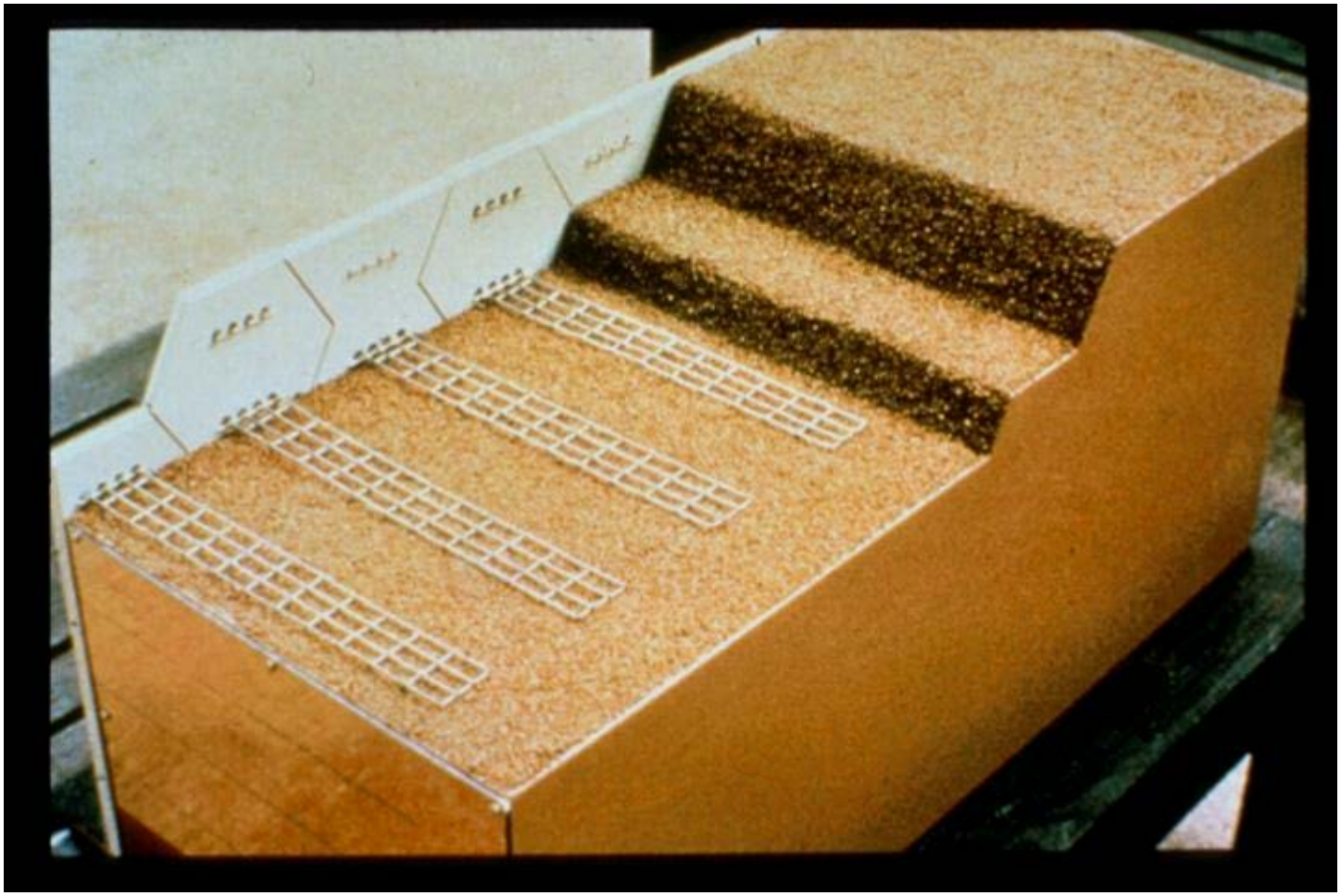




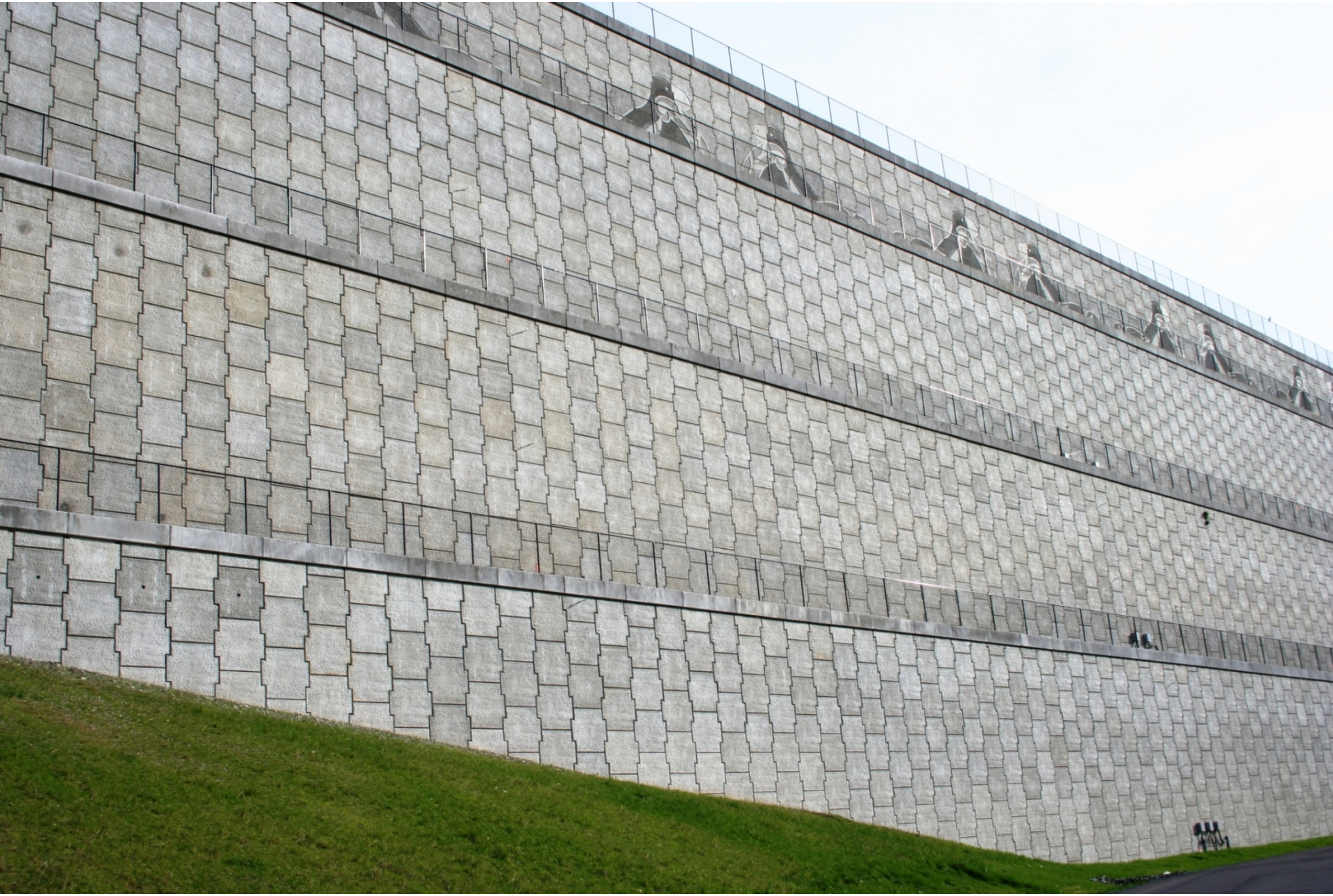
Mechanically Stabilized Earth Wall (MSE Wall)

Mechanically Stabilized Earth Wall (MSE Wall)

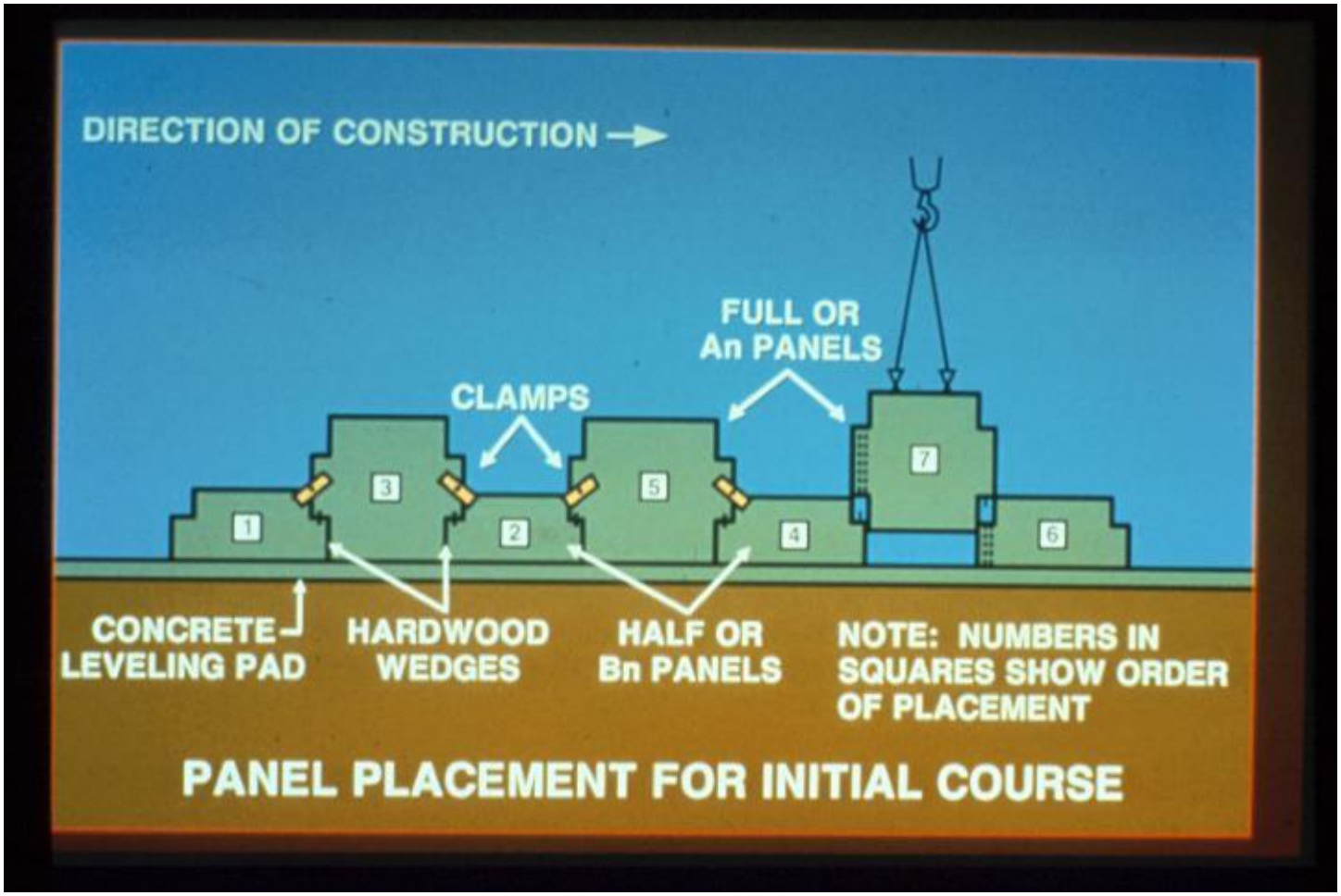
Using Galvanized Steel

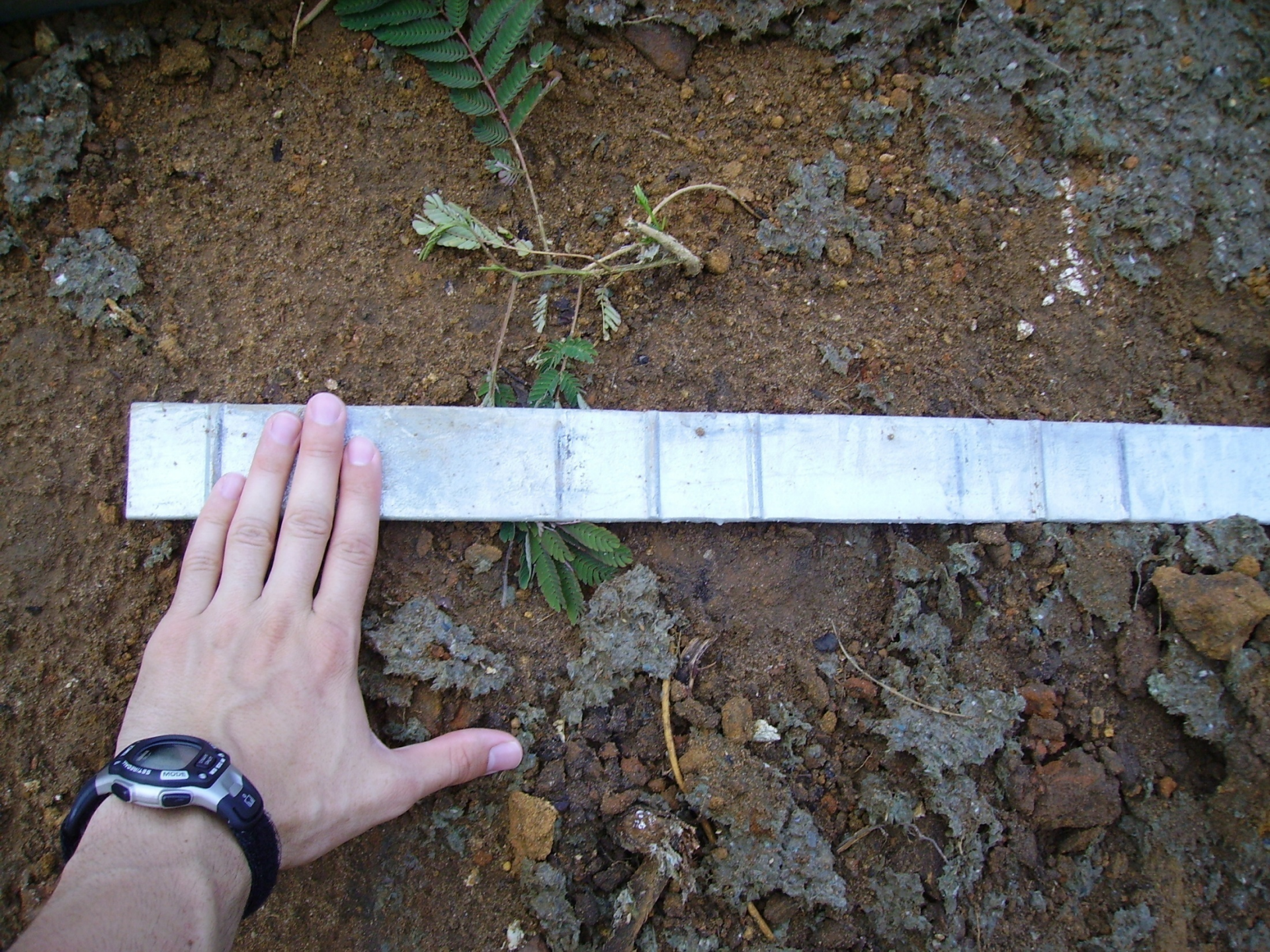


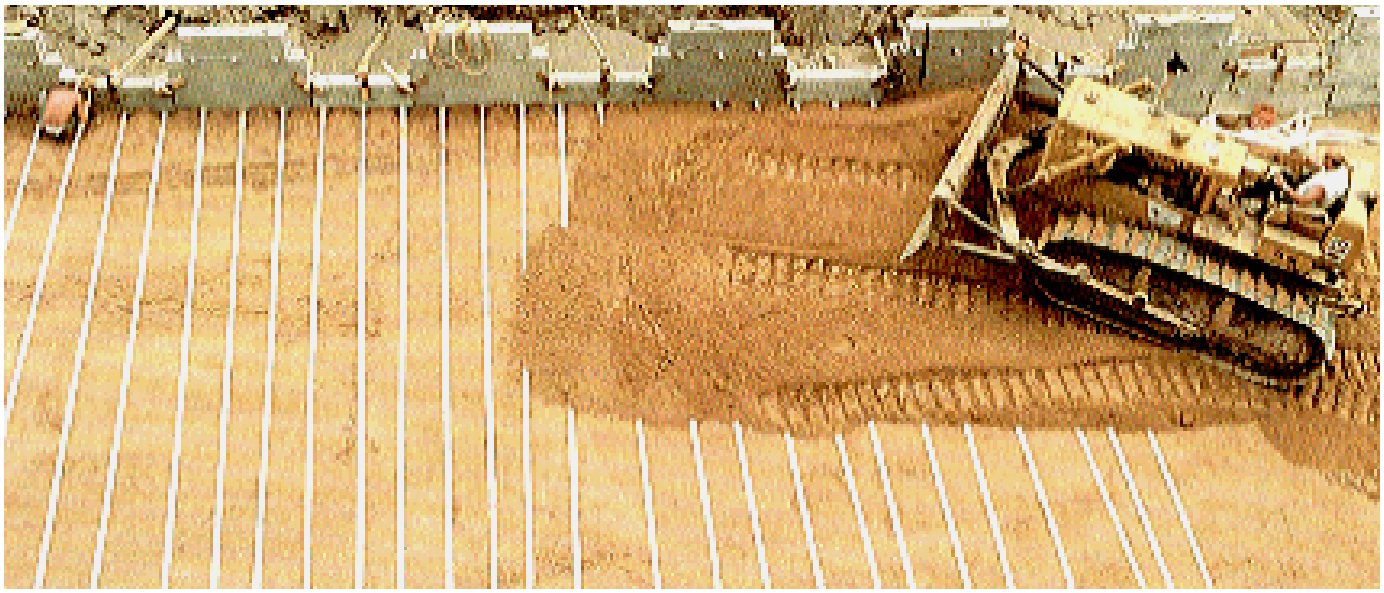
Seattle-Tacoma International Airport, WA



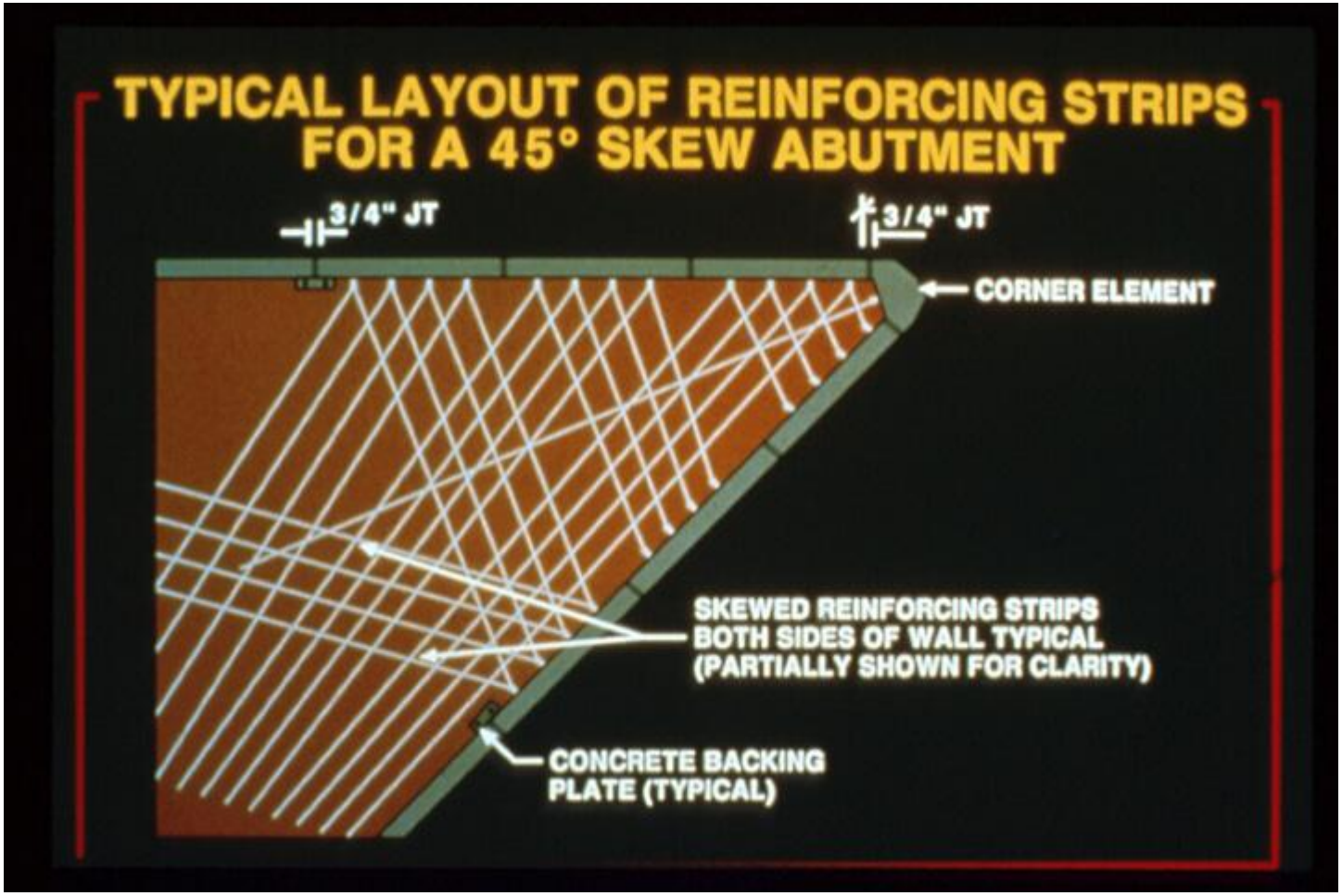

UNIFORMS
636-4080


DIRECTION OF CONSTRUCTION
FULL OR
An PANELS
CLAMPS
1
2
3
4
5
6
7
CONCRETE
LEVELING PAD
HARDWOOD
WEDGES
HALF OR
Bn PANELS
NOTE: NUMBERS IN
SQUARES SHOW ORDER
OF PLACEMENT
PANEL PLACEMENT FOR INITIAL COURSE

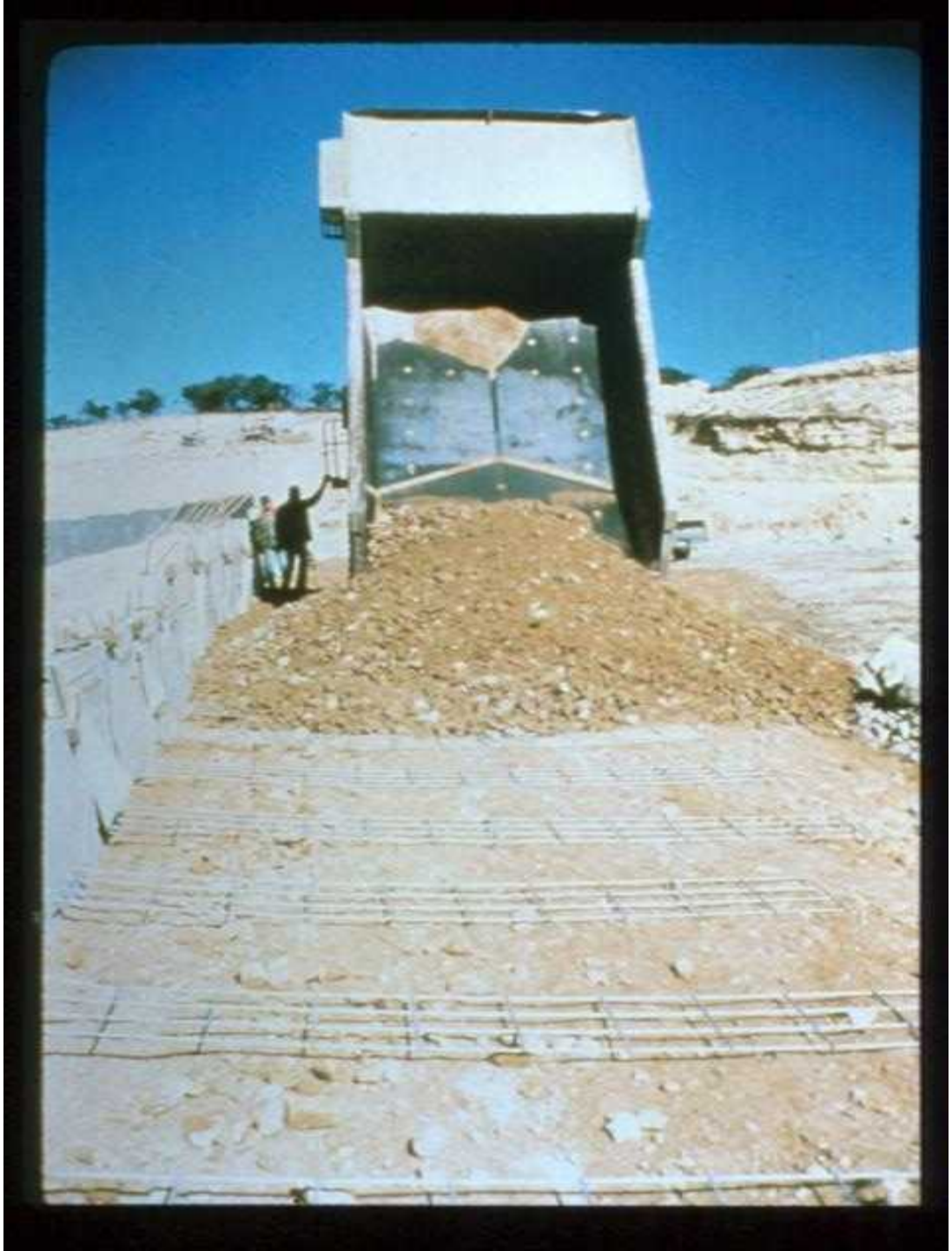




Mechanically Stabilized Earth Wall (MSE Wall)


TYPICAL LAYOUT OF REINFORCING STRIPS FOR A 45° SKEW ABUTMENT
3/4" JT
3/4" JT
CORNER ELEMENT
SKEWED REINFORCING STRIPS
BOTH SIDES OF WALL TYPICAL
(PARTIALLY SHOWN FOR CLARITY)
CONCRETE BACKING
PLATE (TYPICAL)


Dump slab
TerraPlus® facing panels
General backfill
Reinforced Earth block (select backfill)
Drainage layer
REhas® reinforcing strips
Levelling pad

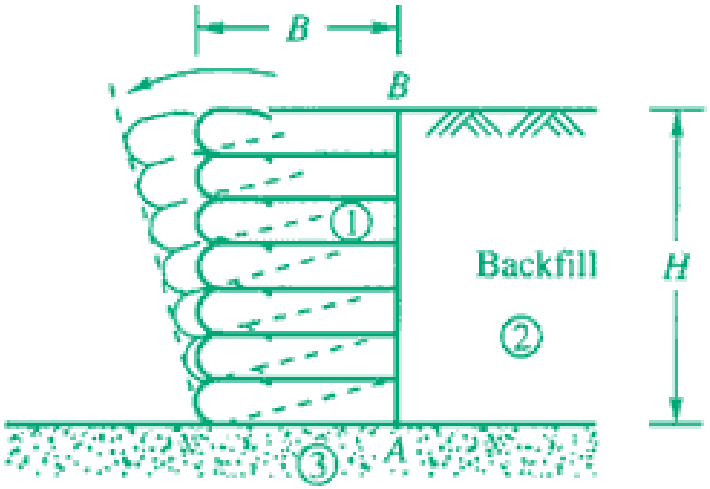


Using Geogrids

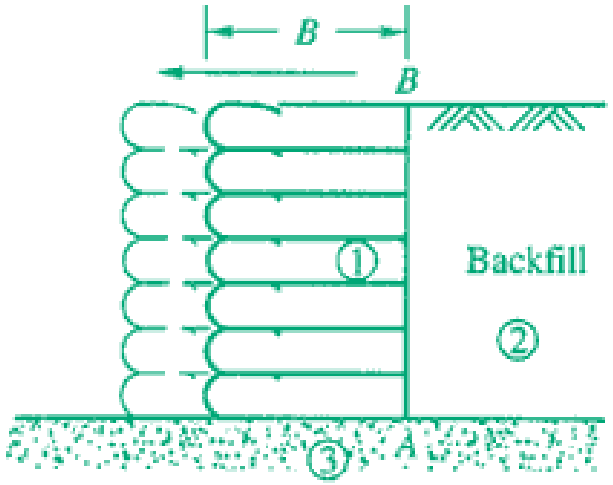
Tom Landry Highway, TX

Stability of MSE Walls

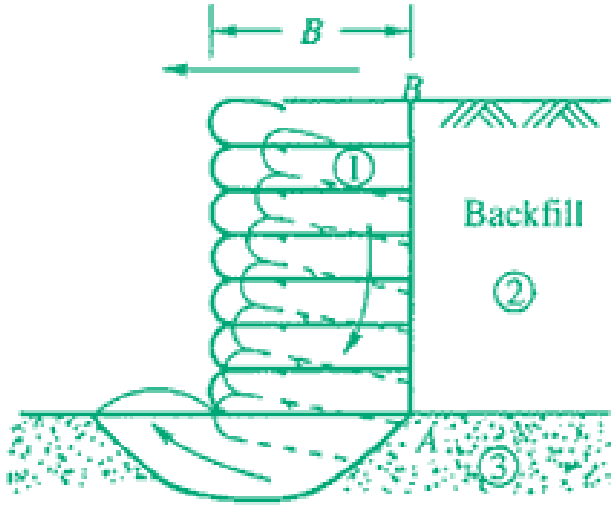
Stability of MSE Walls



(a) Overturning considerations



(b) Sliding considerations

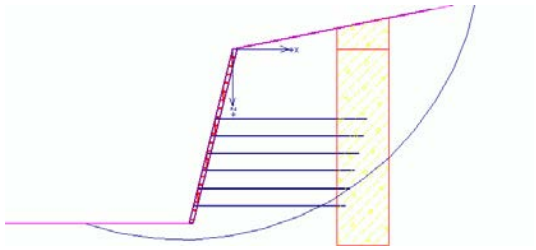


(c) Foundation considerations

① Wall

② Backfill

③ Foundation soil



Block Failure

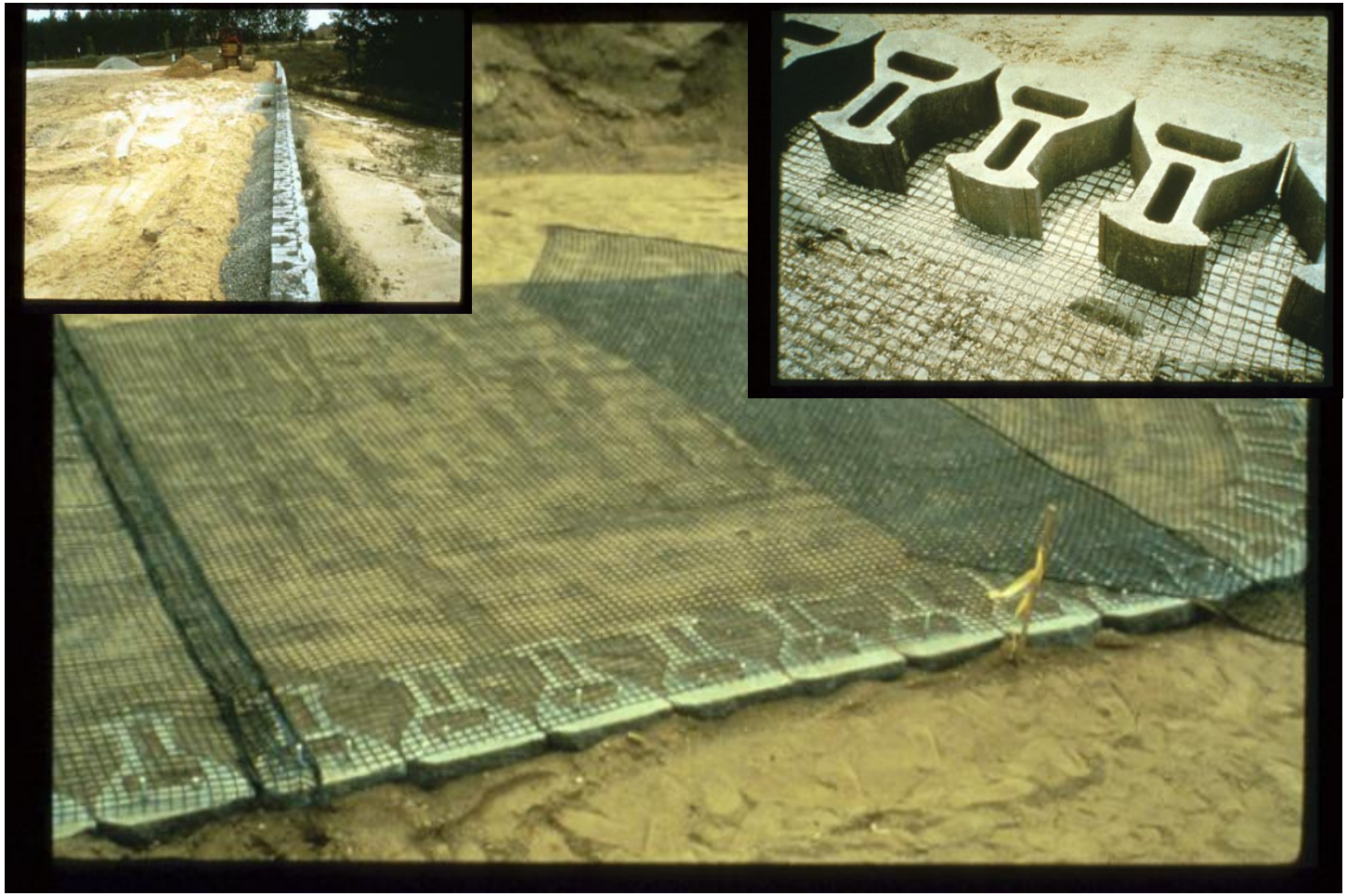
Geotechnical Design
CEG 4801
Fall 2004
By: Dr. Kamal Tawfiq

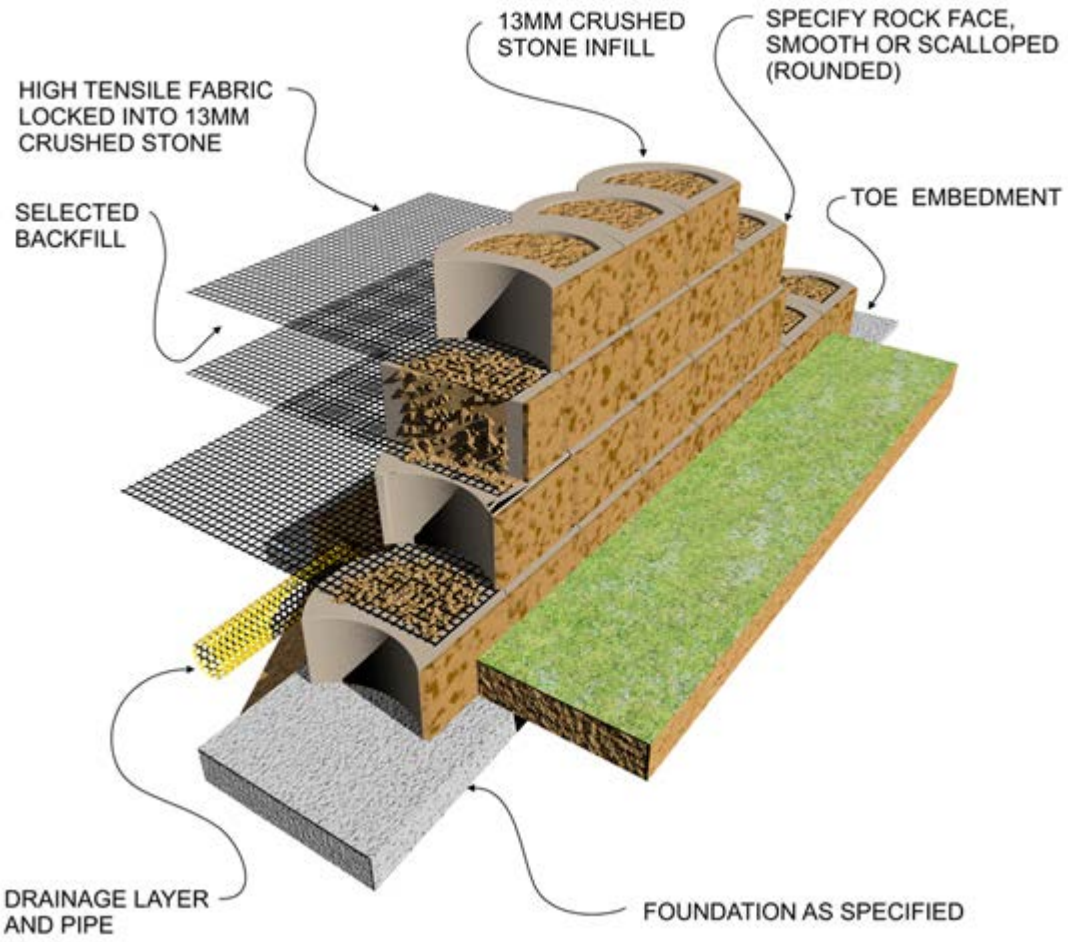
Mechanically Stabilized Earth Wall (MSE Wall)

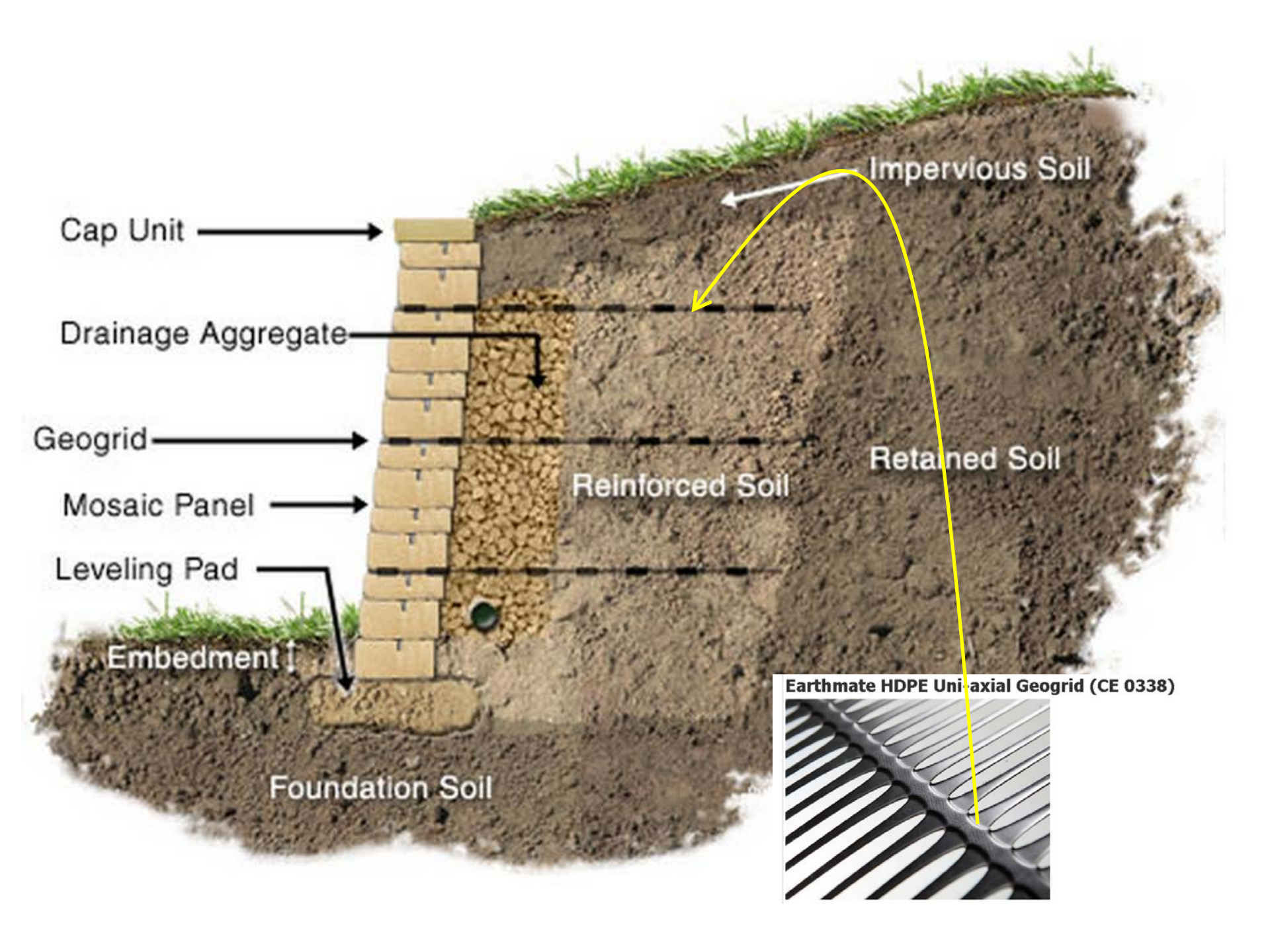
Mechanically Stabilized Earth Wall (MSE Wall)

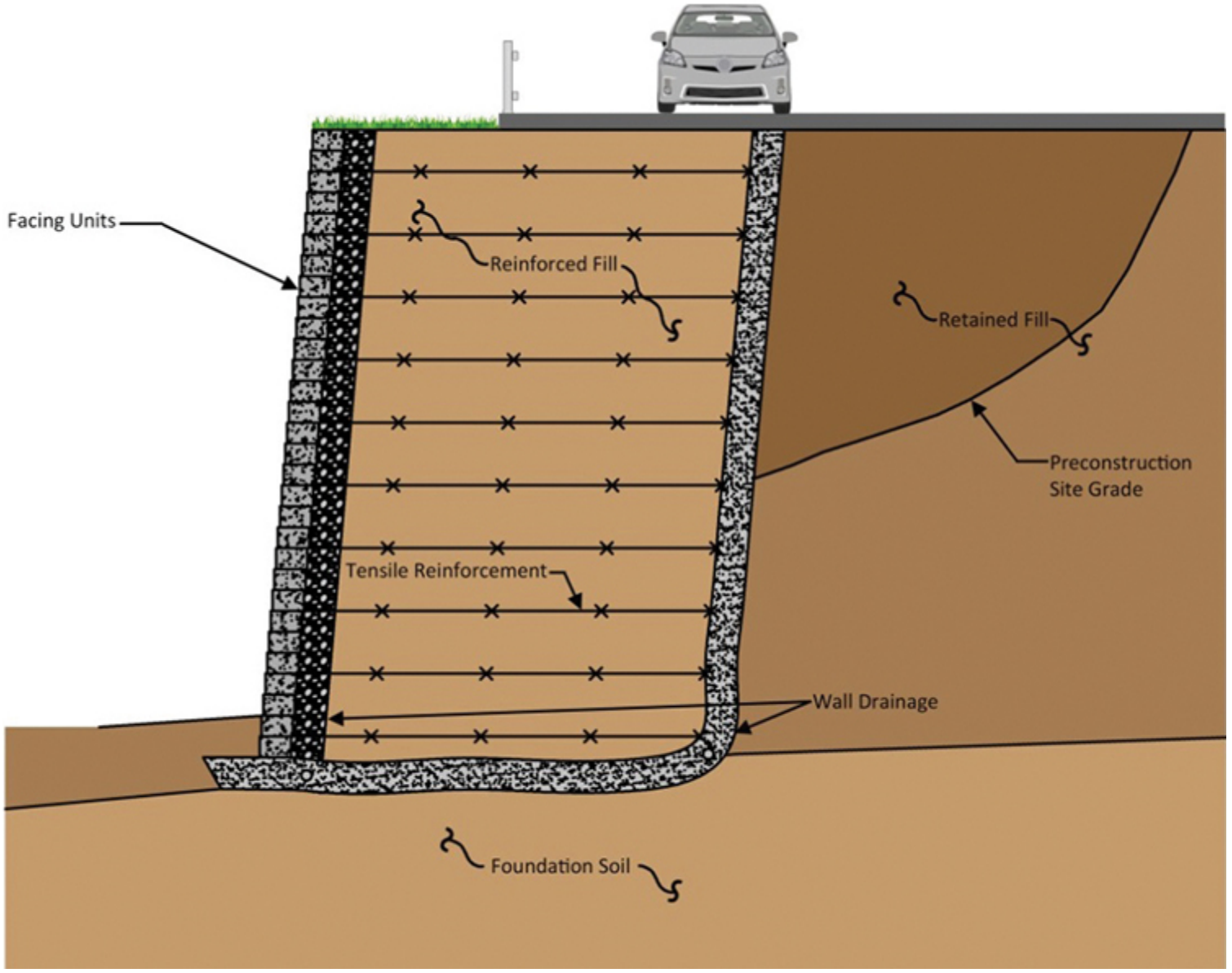
MSE Key Stone Wall

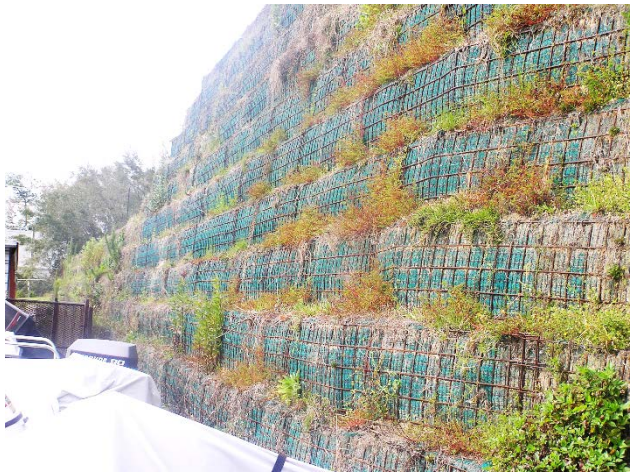
MSE Key Stone Wall




13MM CRUSHED
STONE INFILL
SPECIFY ROCK FACE,
SMOOTH OR SCALLOPED
(ROUNDED)
HIGH TENSILE FABRIC
LOCKED INTO 13MM
CRUSHED STONE
TOE EMBEDMENT
SELECTED
BACKFILL
DRAINAGE LAYER
AND PIPE
FOUNDATION AS SPECIFIED


Impervious Soil
Cap Unit
Drainage Aggregate
Geogrid
Mosaic Panel
Leveling Pad
Embedment
Reinforced Soil
Retained Soil
Foundation Soil
Earthmate HDPE Uni-axial Geogrid (CE 0338)

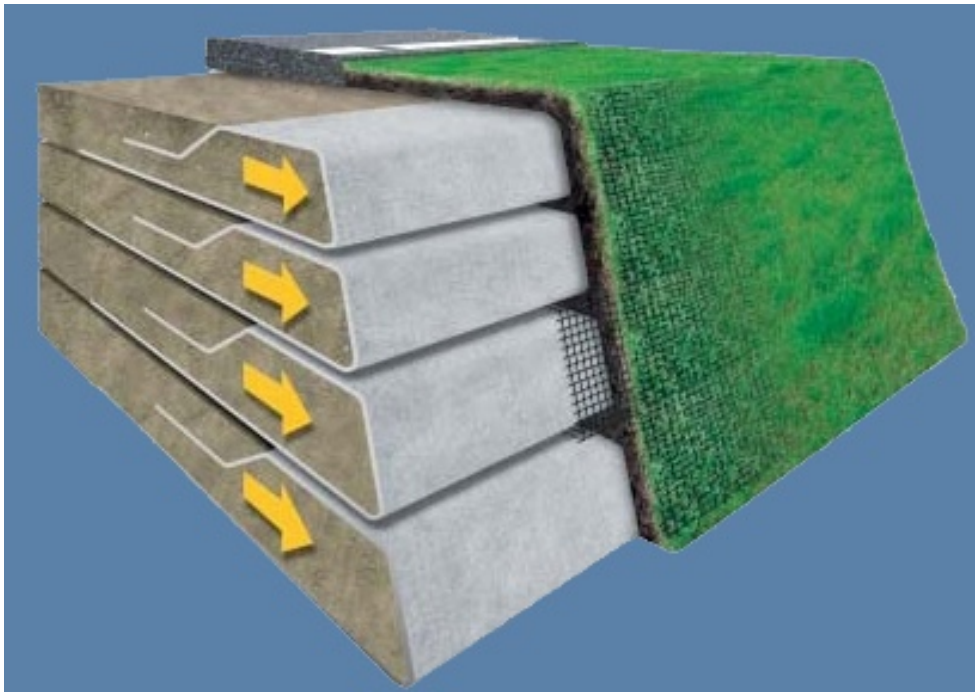

Facing Units
Reinforced Fill
Retained Fill
Preconstruction
Site Grade
Tensile Reinforcement
Wall Drainage
Foundation Soil

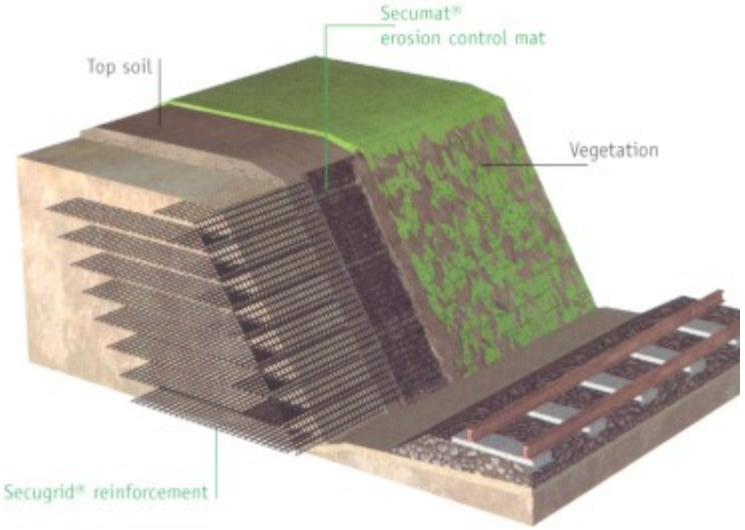


MMESH
Geosynthetic
MMESH
Geosynthetic
Reinforcement
MMESH
Geosynthetic
MMESH
Geosynthetic
Reinforcement
Wire Mesh
Basket Facing
Reinforcement

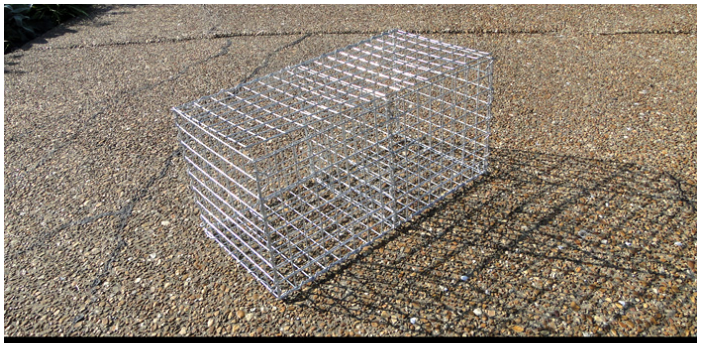

STOP
ENTER CODE
TO EXIT

Geotextile Walls

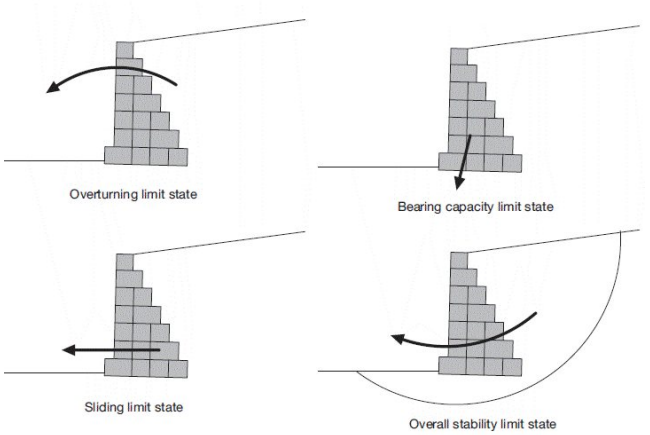




Gabion Walls



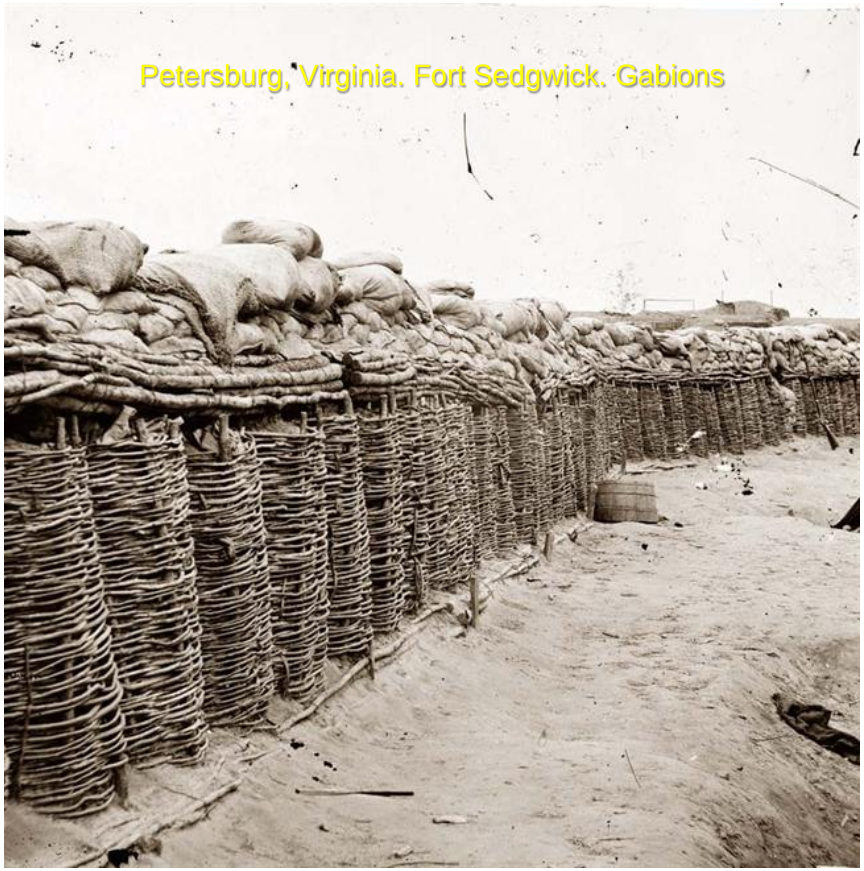
Gabion Retaining Wall Design



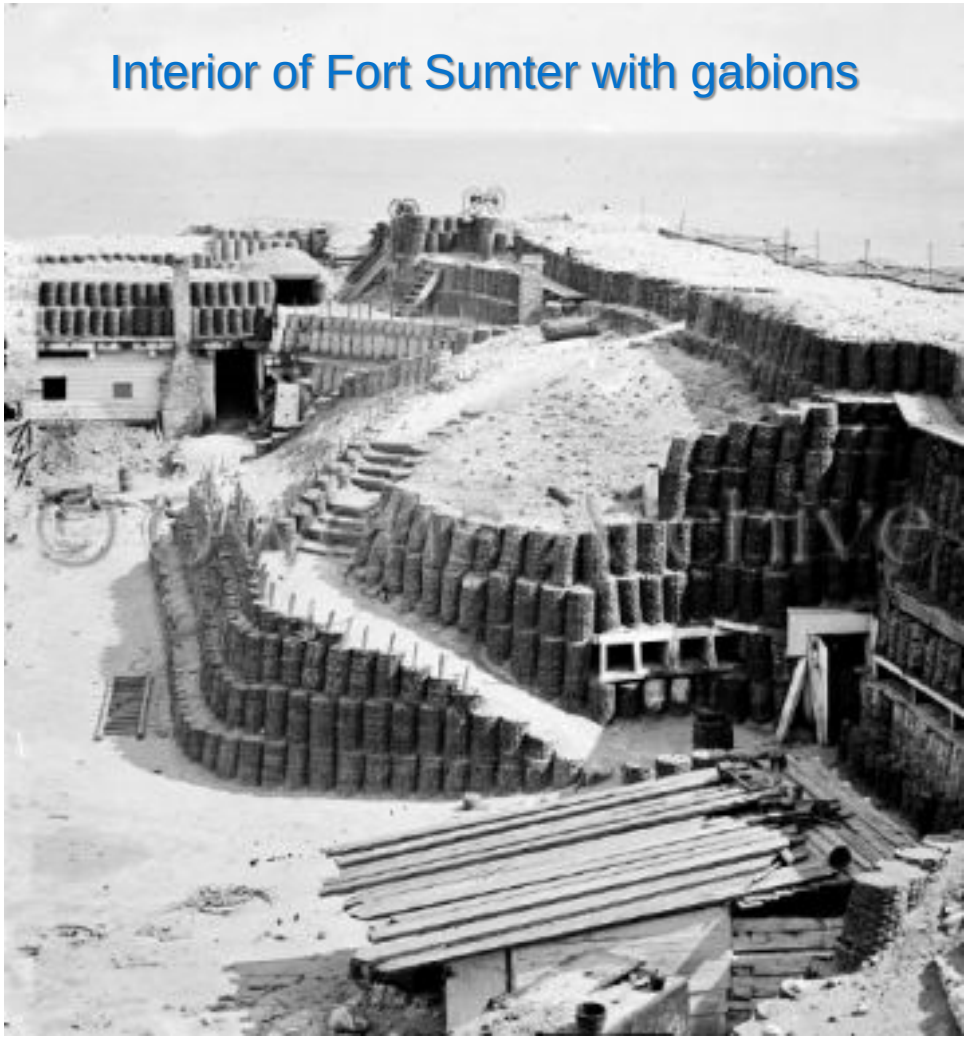
Gabion Walls

HESCO CONCERTAINER

Military Accommodation Roofing, Personnel & Material Bunker Sets



Interior of Fort Sumter with gabions



PHOTOGRAPHIC HISTORY

Interior of the Union Fort Sedgwick, called by the Rebel Soldiers "Fort Hell," showing Union soldiers on the breastworks.

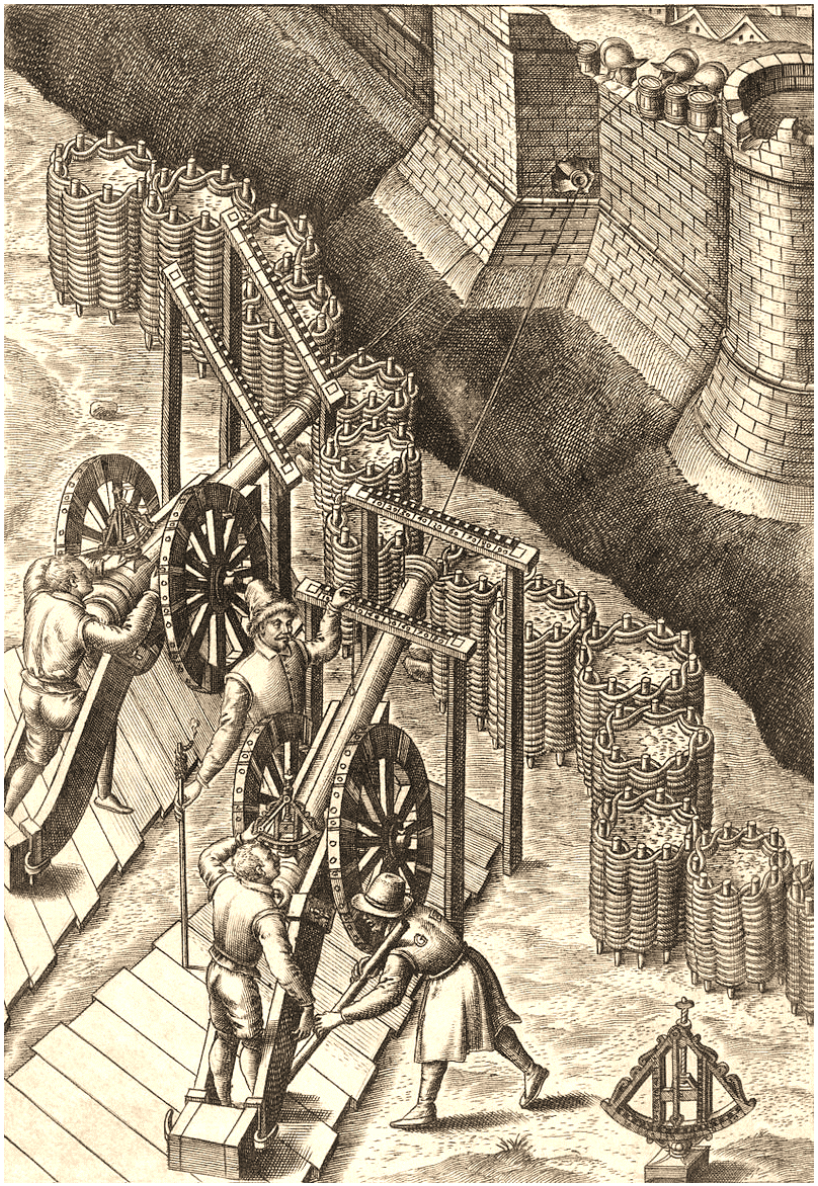
This View was taken the Morning after the storming of Petersburgh, Va., April 2d, 1865.

Entered according to Act of Congress in the year 1865, by E. & H. T. Anthony & Co. in the Clerk's Office of the District Court of the U.S. for the So. District of New-York.

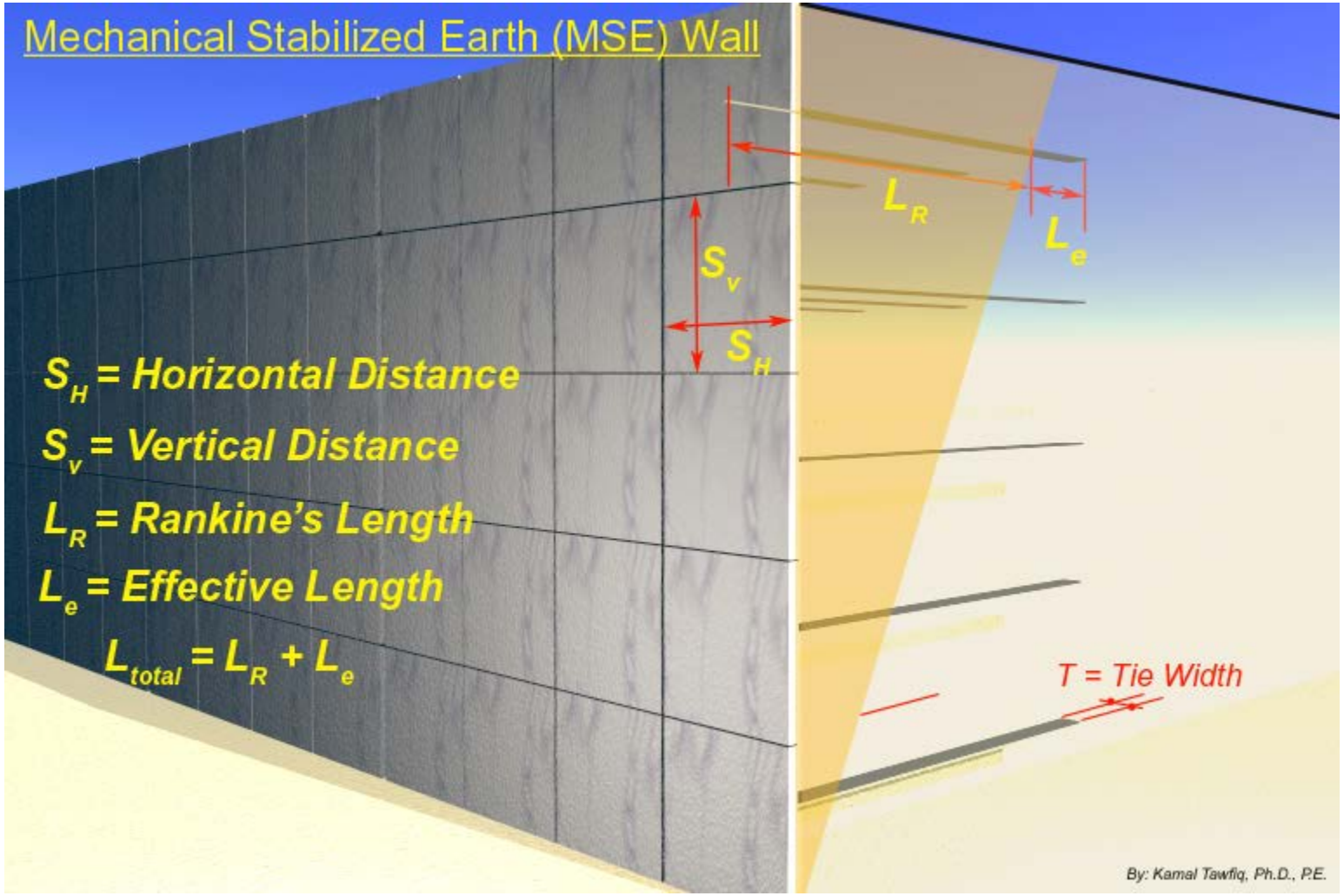
THE WAR FOR THE UNION.

Rebel fortifications in front of Atlanta, Georgia, in 1863 or 1864

Gabions with cannon, from a late 16th century illustration.

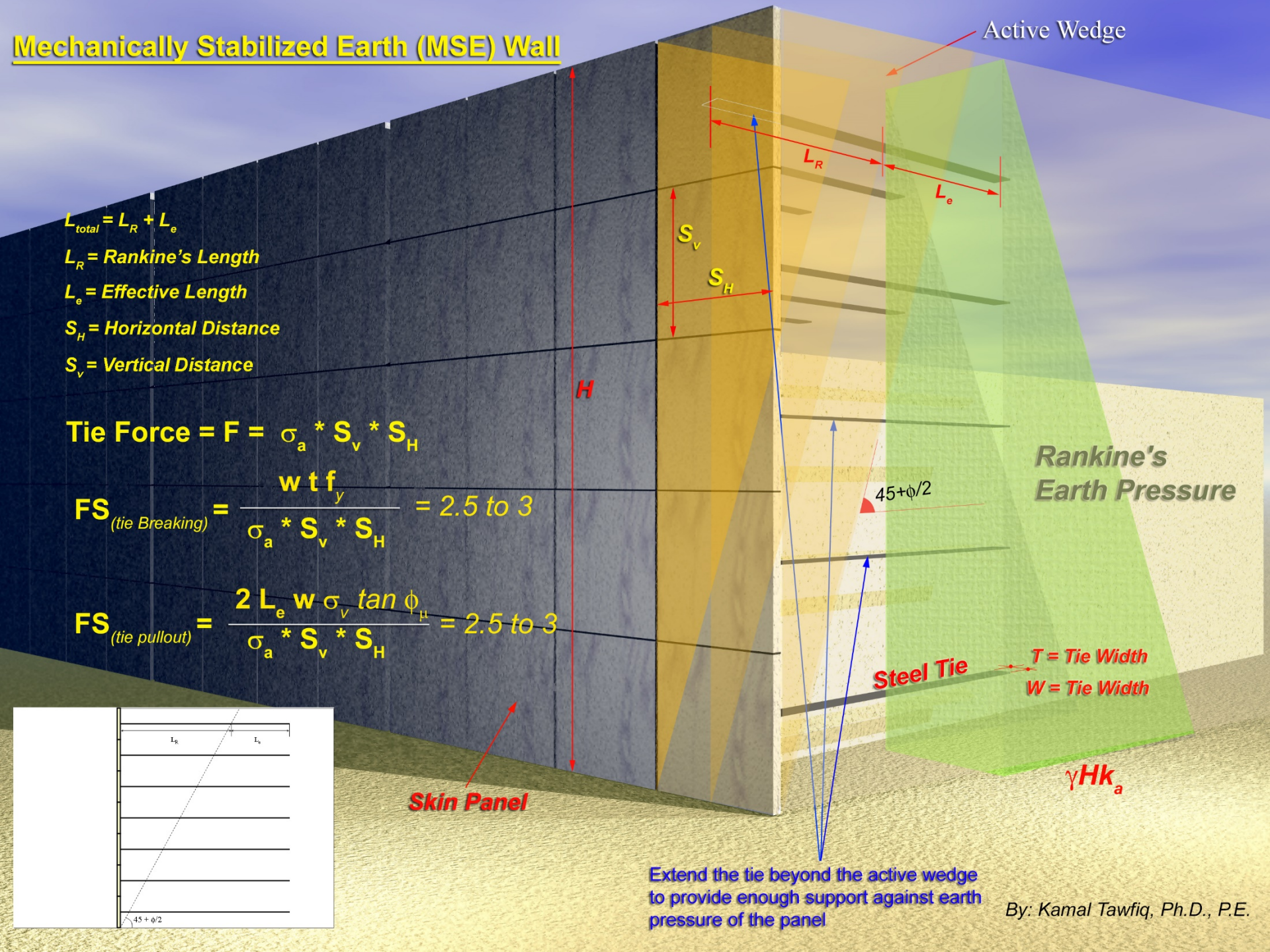


MSE Wall
Analysis and Design



A reinforced earth retaining wall is to be **<u>30 ft high</u>**. The properties of the backfill material are $\gamma = 110$ lb/ft^3 and $\phi = 30^o$. Galvanized steel ties are to be used for the construction of the wall. Design the Reinforcements with $FS_{(B)} = 3$, $FS_{(p)} = 3$, $f_y = 29{,}000$psi and $\phi_{tie} = 20^o$. The properties of the in-situ soil below the retaining wall are $\gamma = 120$ lb/ft^3, $\phi = 30^o$, and $c = 150$ lb/ft^2. Design the panels and the ties of the wall.

Mechanically Stabilized Earth (MSE) Wall



$L_{total} = L_R + L_e$

L_R = Rankine's Length

L_e = Effective Length

S_H = Horizontal Distance

S_v = Vertical Distance

$$\text{Tie Force} = F = \sigma_a * S_v * S_H$$

$$FS_{(\text{tie Breaking})} = \frac{w\ t\ f_y}{\sigma_a * S_v * S_H} = 2.5 \text{ to } 3$$

$$FS_{(\text{tie pullout})} = \frac{2\ L_e\ w\ \sigma_v \tan \phi_\mu}{\sigma_a * S_v * S_H} = 2.5 \text{ to } 3$$

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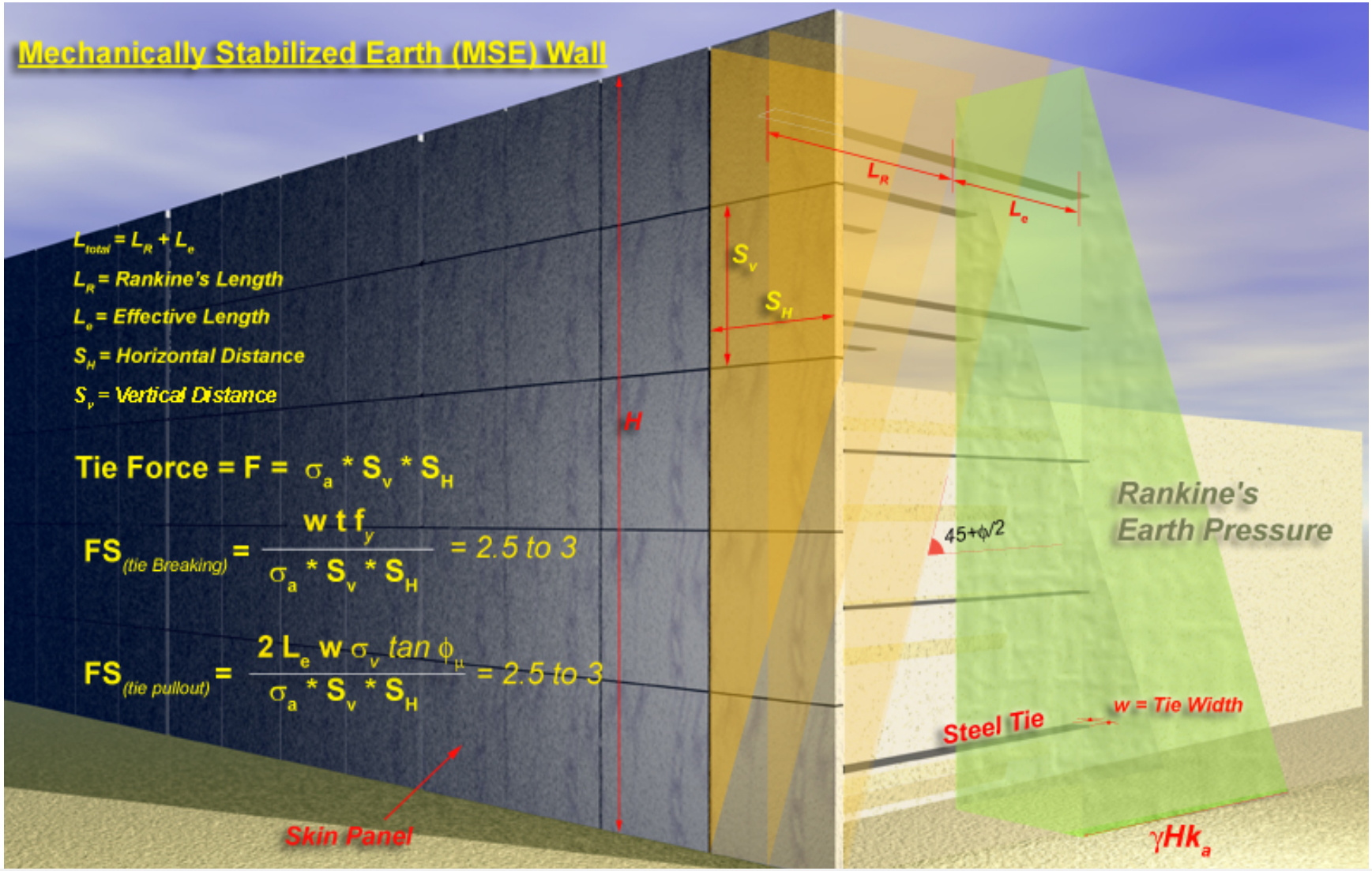


A reinforced earth retaining wall is to be **30 ft high**. The properties of the backfill material are $\gamma = 110$ lb/ft^3 and $\phi = 30^o$. Galvanized steel ties are to be used for the construction of the wall. Design the Reinforcements with $FS_{(B)} = 3$, $FS_{(p)} = 3$, $f_y = 29{,}000$psi and $\phi_{tie} = 20^o$. The properties of the in-situ soil below the retaining wall are $\gamma = 120$ lb/ft^3, $\phi = 30^o$, and c = 150 lb/ft^2. Design the panels and the ties of the wall.

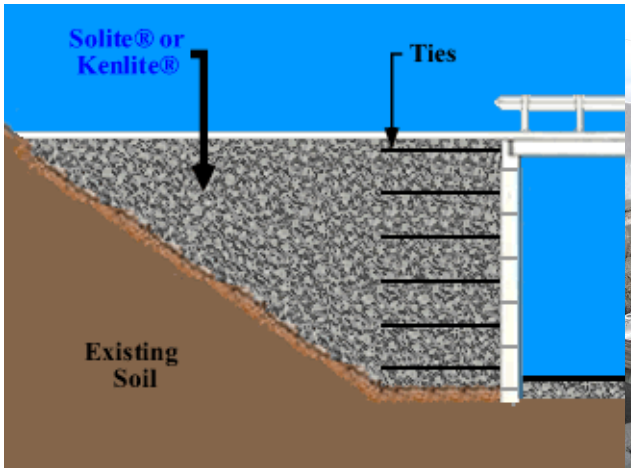
MSE Wall Project

Geotechnical Design

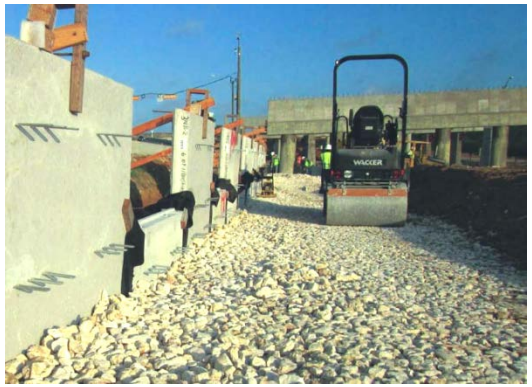
CEG 4801

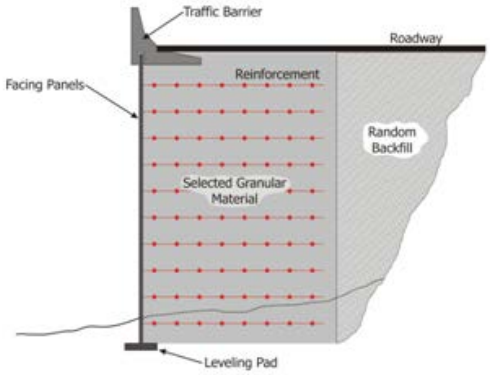
Fall 2016

Kamal Tawfiq, Ph.D., P.E.

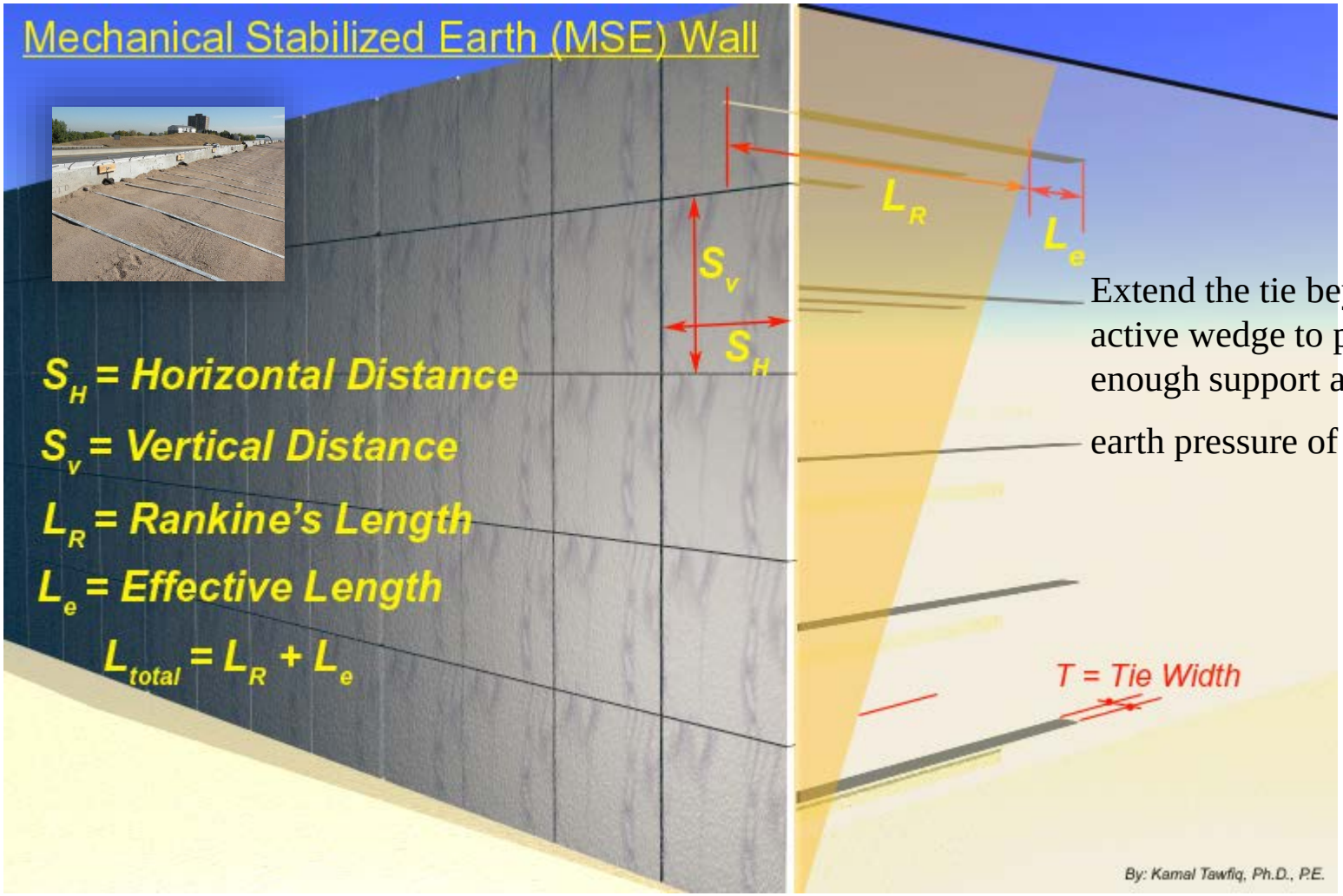

Solite® or
Kenlite®
Ties
Existing
Soil


EXPO COPYRIGHTED 2010




Traffic Barrier
Roadway
Reinforcement
Facing Panels
Random
Backfill
Selected Granular
Material
Leveling Pad

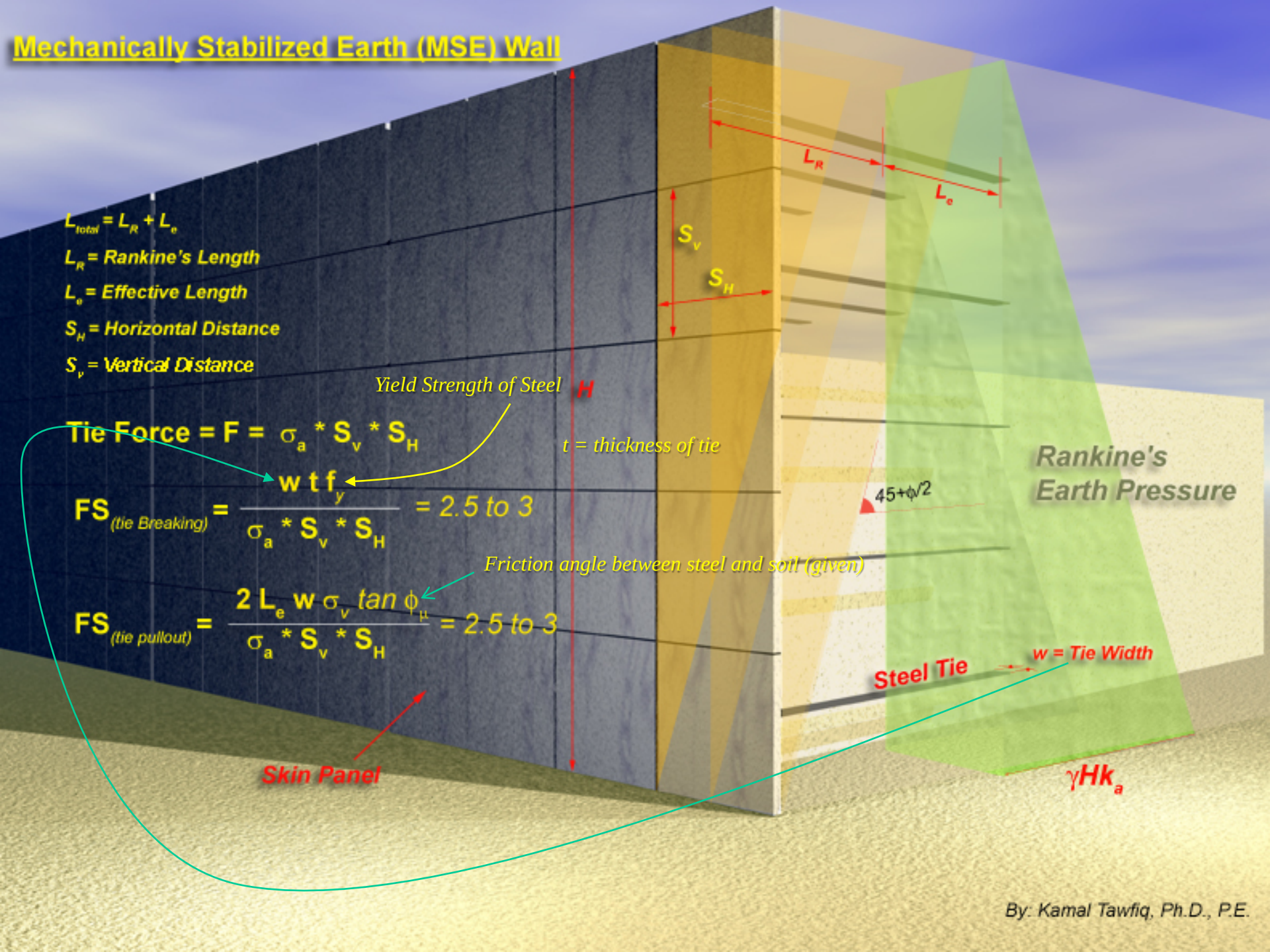
Design Concept



Extend the tie beyond the active wedge to provide enough support against earth pressure of the panel

A reinforced earth retaining wall is to be **30 ft high**. The properties of the backfill material are $\gamma = 110$ lb/ft^3 and $\phi = 30^o$. Galvanized steel ties are to be used for the construction of the wall. Design the Reinforcements with $FS_{(B)} = 3$, $FS_{(p)} = 3$, $f_y = 29{,}000$psi and $\phi_{tie} = 20^o$. The properties of the in-situ soil below the retaining wall are $\gamma = 120$ lb/ft^3, $\phi = 30^o$, and $c = 150$ lb/ft^2. Design the panels and the ties of the wall.

Mechanically Stabilized Earth (MSE) Wall



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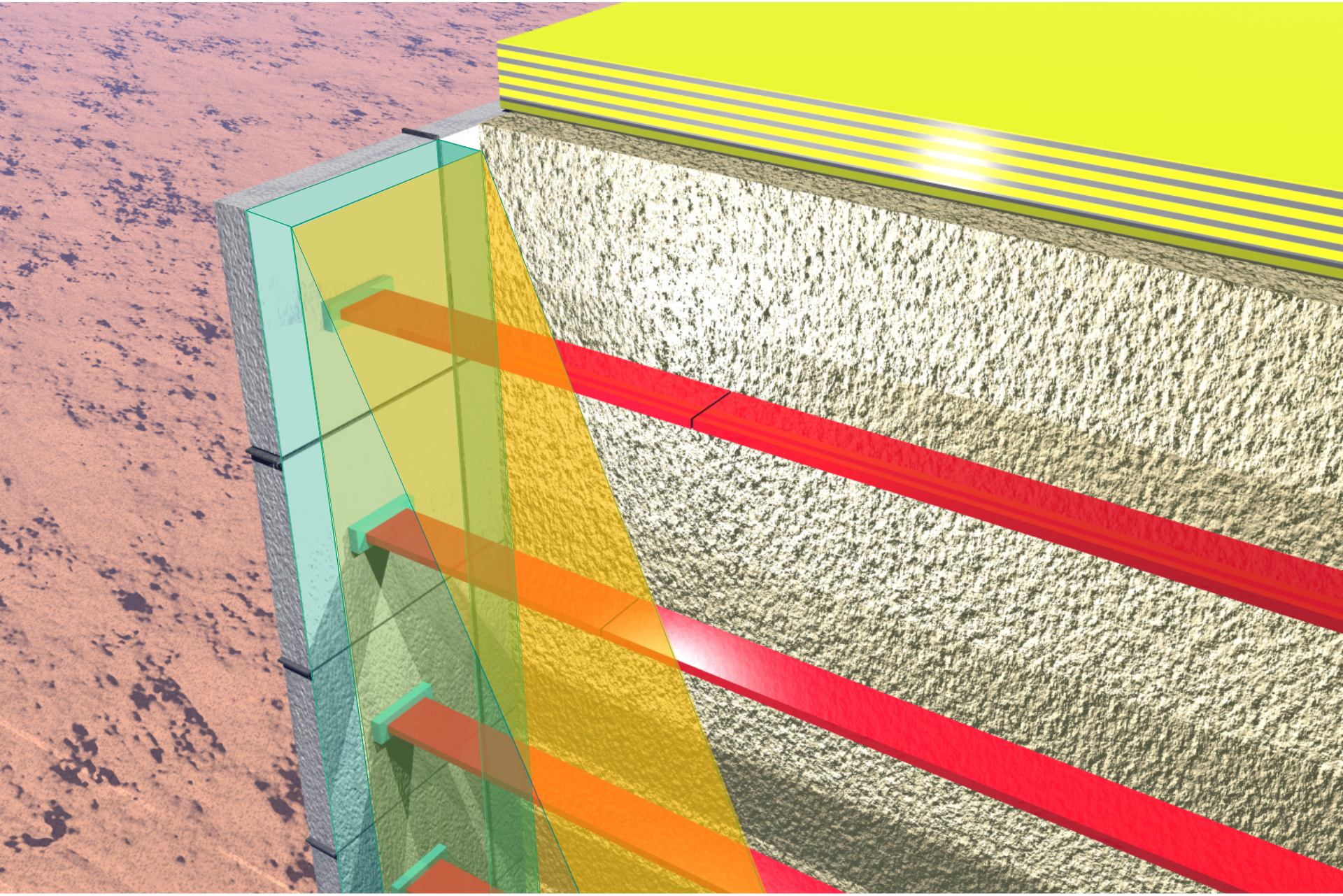
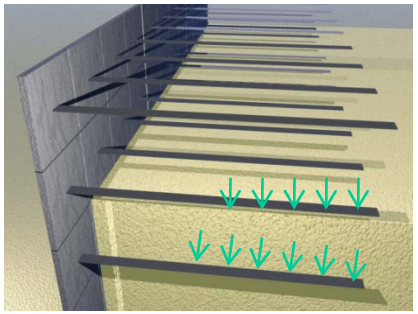
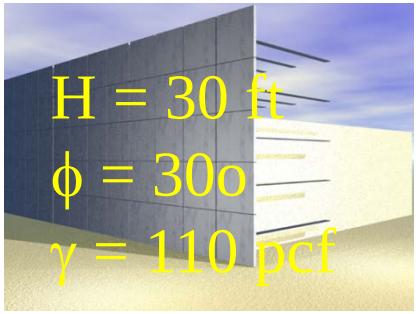


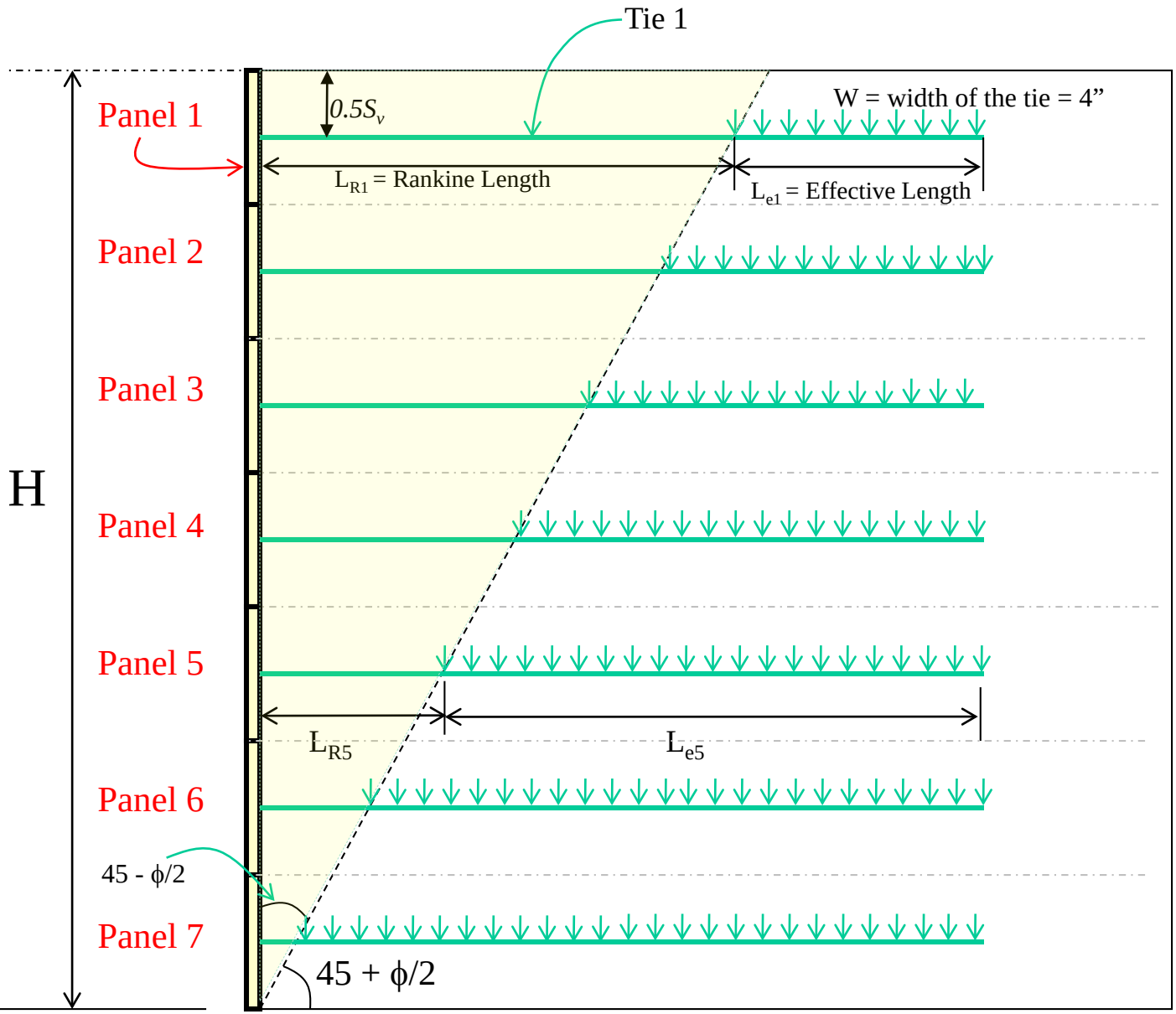
$L_{R1} = (H - 0.5\ S_v) \tan(45 - \phi/2)$

$$L_{e1} = \frac{2.5(\sigma_a . S_v . S_H)}{2\ w\ \sigma_v \tan\phi_\mu}$$

$$L_1 = L_{R1} + L_{e1}$$







Kamal Tawfiq, Ph.D., P.E.

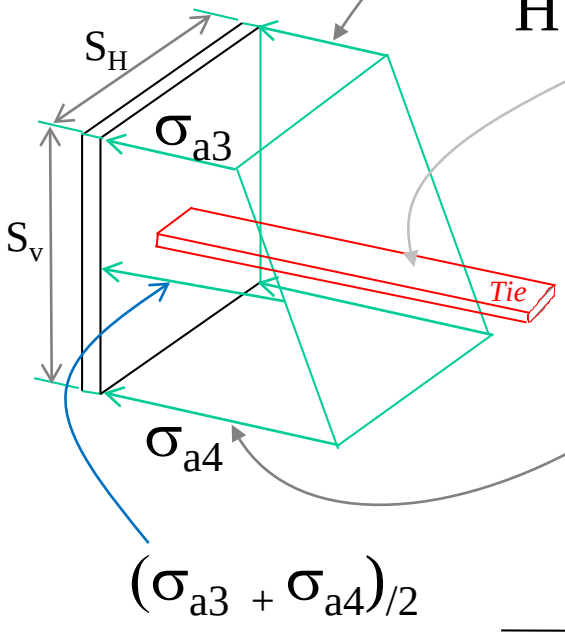
$$L_{R1} = (H - 0.5\,S_v)\tan(45 - \phi/2)$$

$$L_{e1} = \frac{2.5(\sigma_a . S_v . S_H)}{2\,w\,\sigma_v \tan\phi_\mu}$$

$(\sigma_{a1} + \sigma_{a2})/2$

Tie width

$$L_1 = L_{R1} + L_{e1}$$



H

σ_{a1} σ_{v1}
σ_{a2} σ_{v2}
σ_{a3} σ_{v3}
σ_{a4}
σ_{a5}
σ_{a6}
σ_{a7}
σ_{a8}

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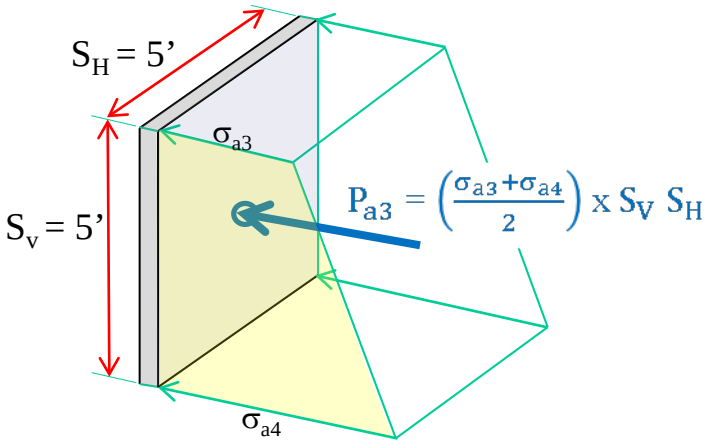
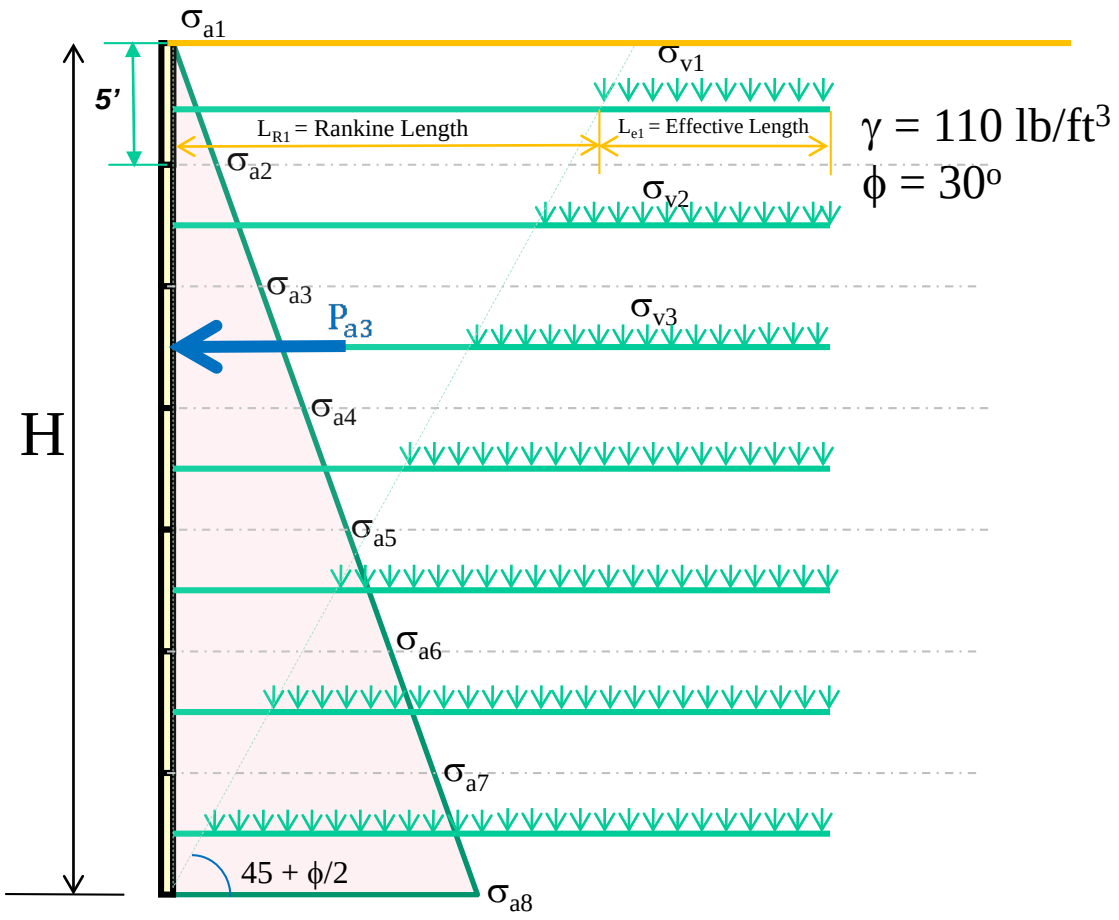
Example:

A reinforced earth retaining wall is to be **30 ft high**. The properties of the backfill material are $\gamma = 110$ lb/ft^3 and $\varphi = 30^o$. Galvanized steel ties are to be used for the construction of the wall. Design the Reinforcements with $FS_{(B)} = 3$, $FS_{(p)} = 3$, $f_y = 29{,}000$ psi and $\varphi_{tie} = 20^o$. The properties of the in-situ soil below the retaining wall are $\gamma = 120$ lb/ft^3, $\varphi = 30^o$, and c = 150 lb/ft^2. Design the panels and the ties of the wall.





Solution:

$$k_a = \frac{1-sin\emptyset}{1+sin\ \emptyset} = \frac{1-sin30}{1+sin\ 30} = 0.33$$

Point	Tie	Depth (ft)	Vertical Stress (σ_V) lb/ft^2	Horizontal Stress (σ_a) lb/ft^2	σ_a . S_v. S_H	σ_v . tanϕ_m	L_e	L_R	L_{total}	$t = s_a$. S_v. $S_{H/w.fy}$
1		0	0	0						
	Tie 1	2.5	275	90.75	2268.75	100.09	102.0	47.63	150	0.058675
2		5	550	181.5						
	Tie 2	7.5	825	272.25	6806.25	300.28	102.0	38.97	141	0.176024
3		10	1100	363						
	Tie 3	12.5	1375	453.75	11343.75	500.46	102.0	30.31	132	0.293373
4		15	1650	544.5						
	Tie 4	17.5	1925	635.25	15881.25	700.64	102.0	21.65	124	0.410722
5		20	2200	726						
	Tie 5	22.5	2475	816.75	20418.75	900.83	102.0	12.99	115	0.528071
6		25	2750	907.5						
	Tie 6	27.5	3025	998.25	24956.25	1101.01	102.0	4.33	106	0.645420
7		30	3300	1089						