Temporary Walls and Pressure Relief Walls

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Tensar Engineered Systems

Objectives

- **Why** consider temporary walls and pressure relief walls
- **Overview** of temporary and pressure relief wall systems
- **Design theory** and introduction to TensarSoil design tool
- **Installation** and system components
- **Example** projects

Market Trends

4.2 %

2019 Real growth in the U.S. transportation infrastructure market

American Road & Transportation Builders Association (ARTBA)

Increased transportation investment from all levels of government - federal, state and local

$278.1bn

Market activity in 2019 $11bn increase on 2018

Temporary Walls and Pressure Relief Walls

Expedite Construction

- Proven MSE wall technology
- Design and installation flexibility
- Logistics efficiencies vs. conventional options
- Simple installation requiring no specialized equipment or labor
- New applications/uses driven by site-specific needs of end users
- Solutions align with fluidity of Design/Build and P3 contracts

General Overview

Grade Separation Systems

Geogrid reinforced
precast panel system

Geogrid reinforced retaining walls (stone-faced or vegetated face)

Segmented block
retaining wall system

Temporary wall systems

Bridge abutments

Geogrid reinforced
slope retention system

Overview – Temporary Walls

Ideal for traffic maintenance, staged construction and similar projects, Tensar Temporary Walls feature:

- Proven performance in heavy load applications
- UX Geogrids. Made from high-density polyethylene (HDPE), uniaxial (UX) geogrids allow the use of a variety of backfill materials
- Ease of installation, with the ability to be left in place or easily removed
- Full-service solutions, including engineered drawings and on-site assistance

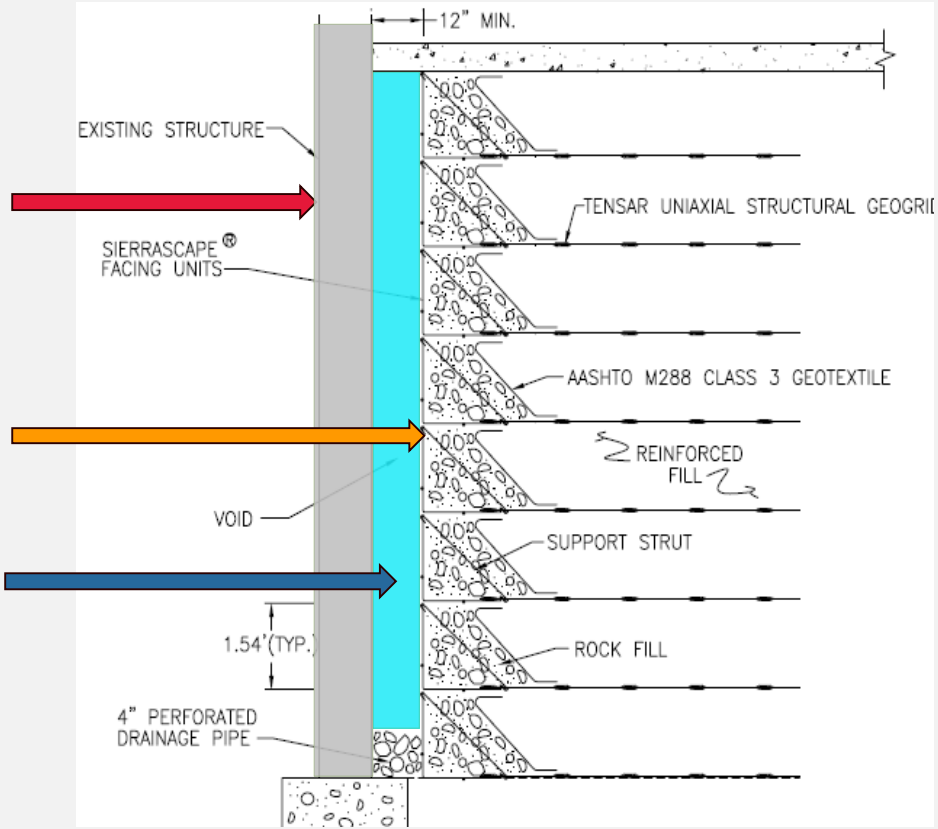
Pressure Relief Walls

The challenge:

- Remove lateral earth pressure loads from an existing or new wall

The solution:

- Build a cost-effective adjacent vertical wall that absorbs those loads
- Leave a void space between to assure no load transfer

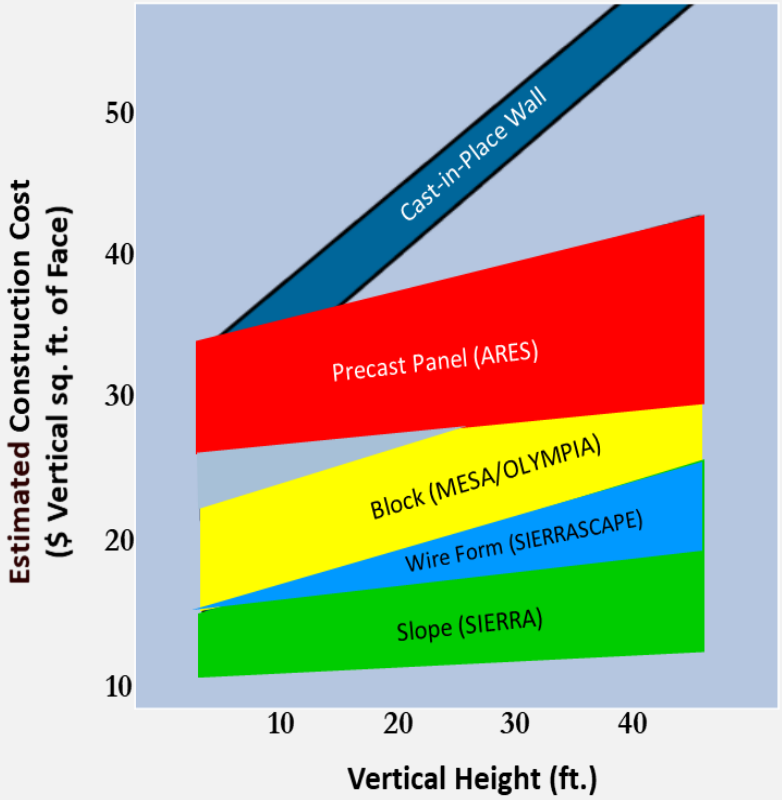


Overview - Pressure Relief Walls

Ideal for veneer fascia, underground walls (parking structures, basement and foundation walls, etc.), unforeseen site challenges, and staged construction and similar projects, Tensar Pressure Relief Walls feature:

- Proven performance in heavy load applications
- UX Geogrids: Made from high-density polyethylene (HDPE), uniaxial (UX) geogrids allow the use of a variety of backfill materials including “hot soils” and recycled concrete
- Ease of installation, requiring no specialized construction equipment or labor
- Full-service solutions, including engineered drawings and on-site assistance

MSE System Cost

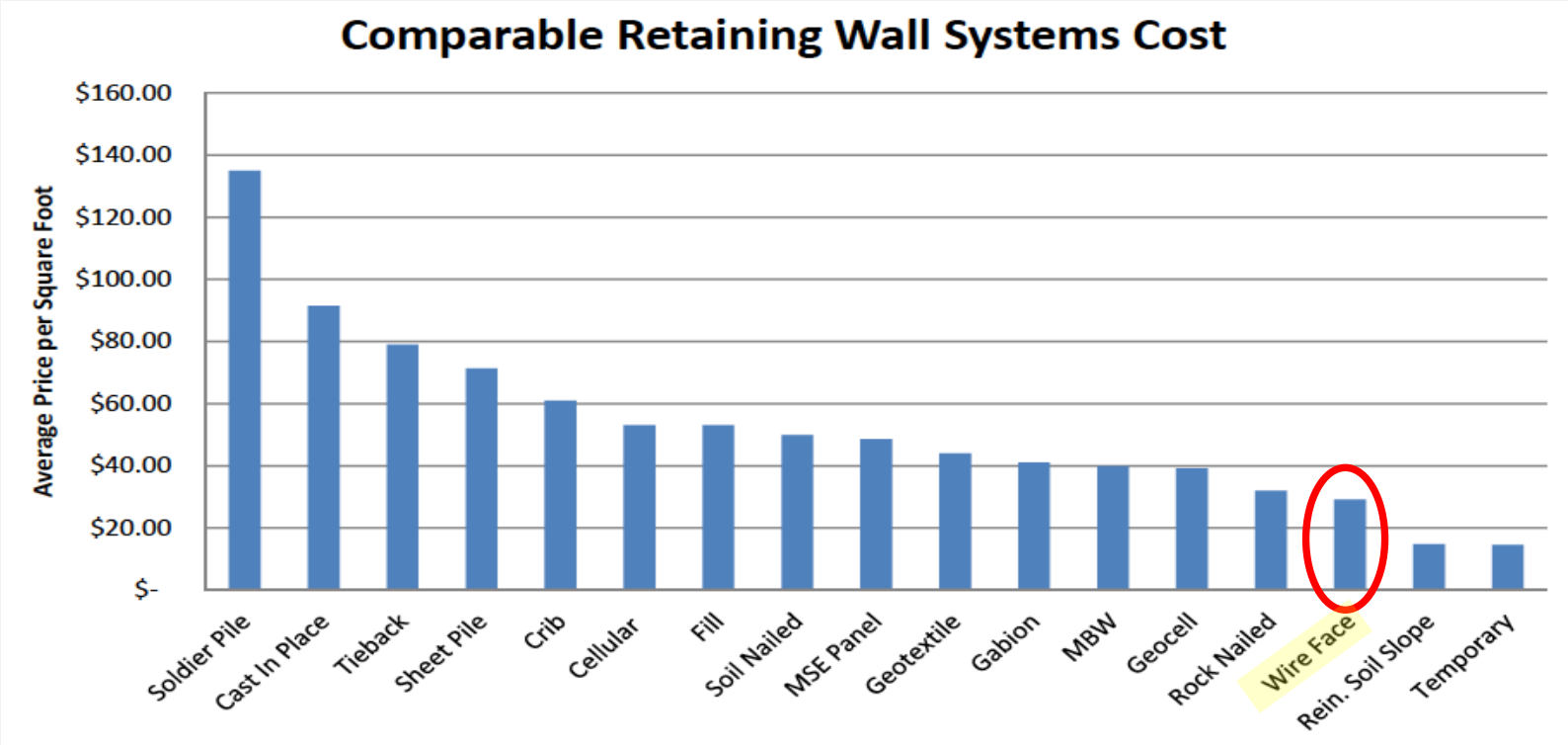


Rule of Thirds – MSE Structures Cost:

- 1/3 Backfill
- 1/3 Labor
- 1/3 Materials*

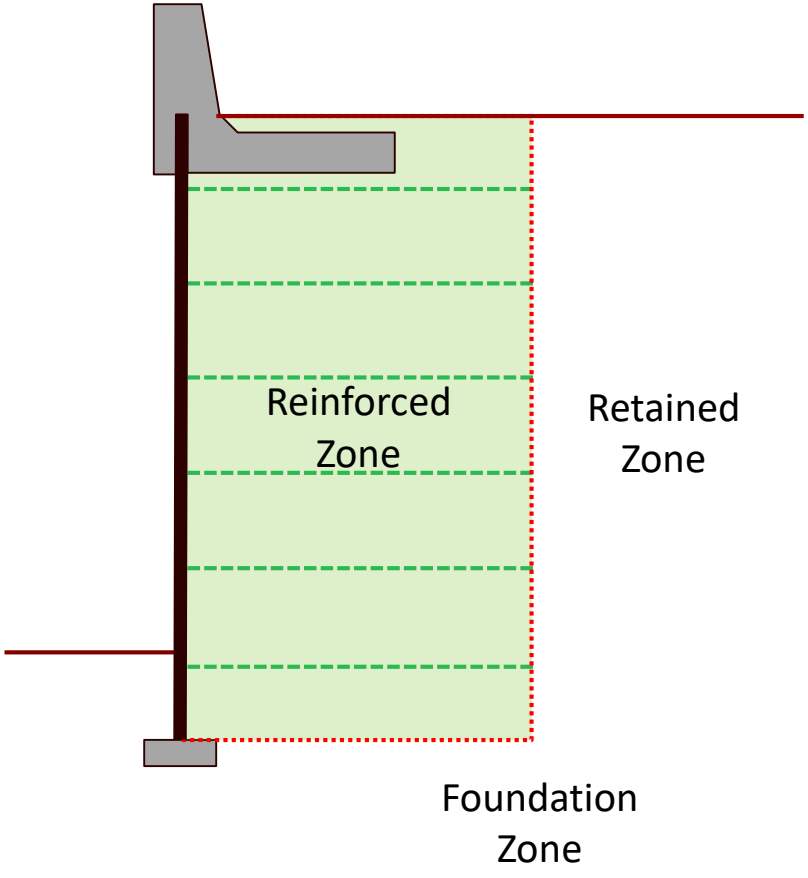
*Fascia ~60%, Geosynthetics ~40%

Cost Comparison



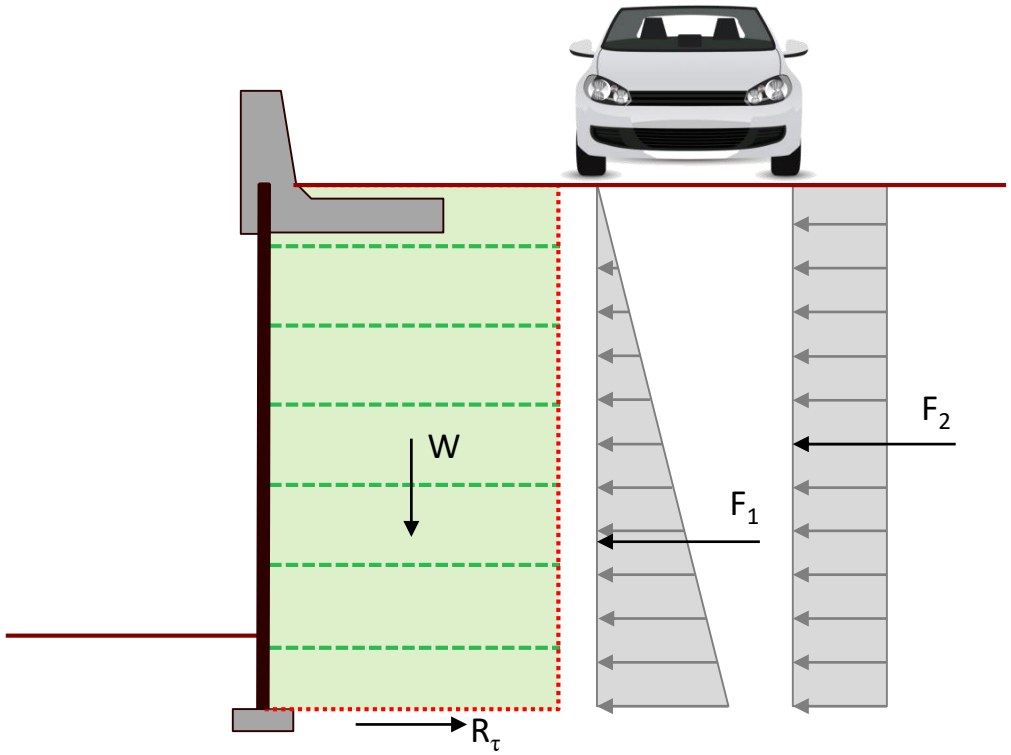
Design Concepts and Tools

Stability of MSE Walls



Reinforced Soil Properties:	γ_{reinf} φ_{reinf}	c_{reinf} 0
Retained Soil Properties:	γ_{ret} φ_{ret}	c_{ret} 0
Foundation Soil Properties:	γ_f φ_f	c_f

External Stability

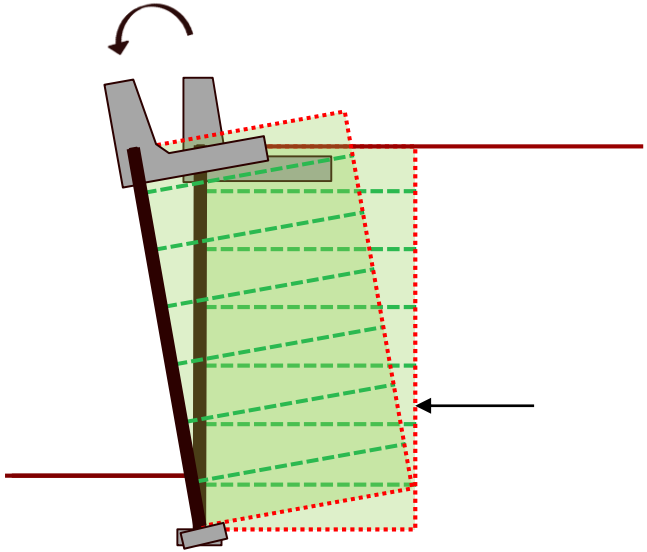


Weight of MSE Mass/Sliding Resistance

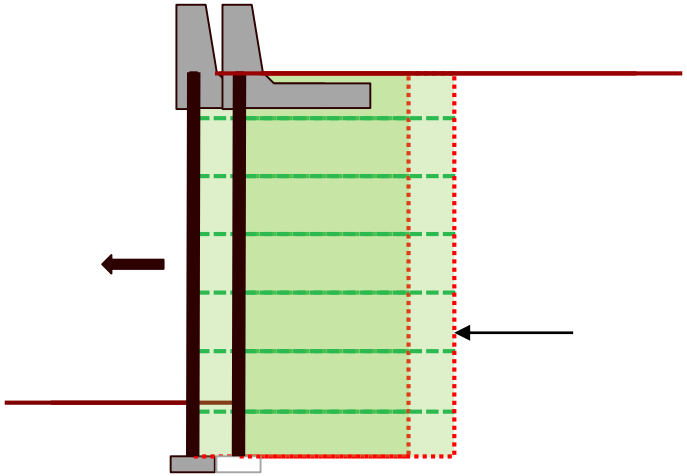
Earth Pressure

Live Load Surcharge

External Stability Continued

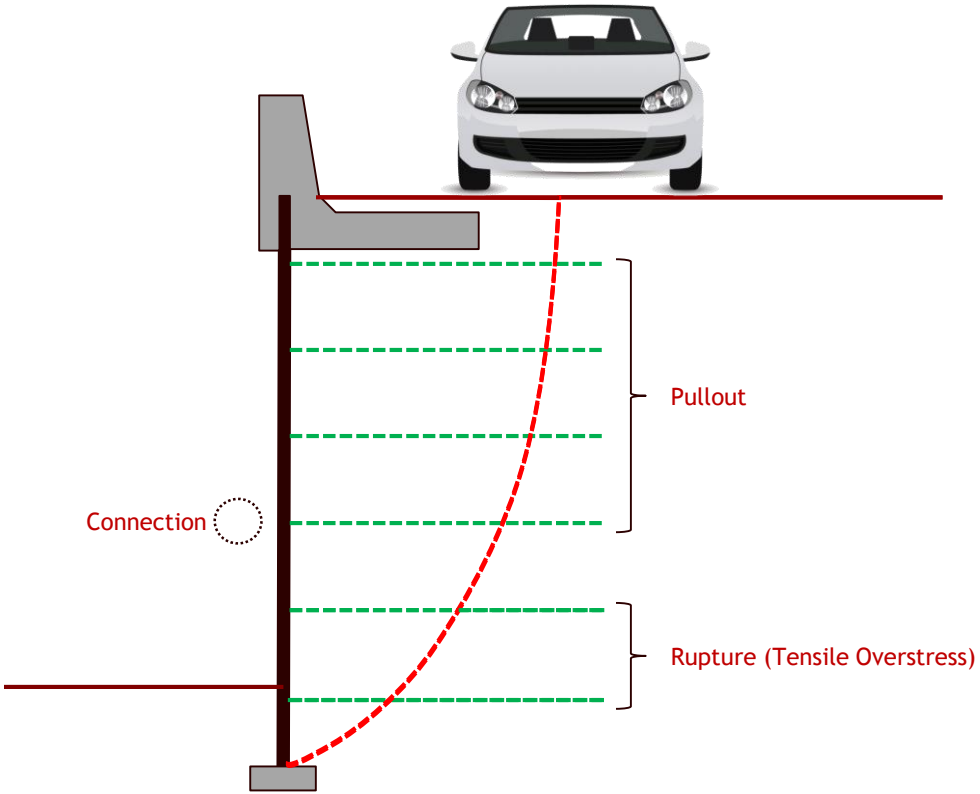


Overturning /
Limiting Eccentricity (AASHTO LRFD)



Sliding

Internal Stability



AASHTO LRFD vs. NCMA

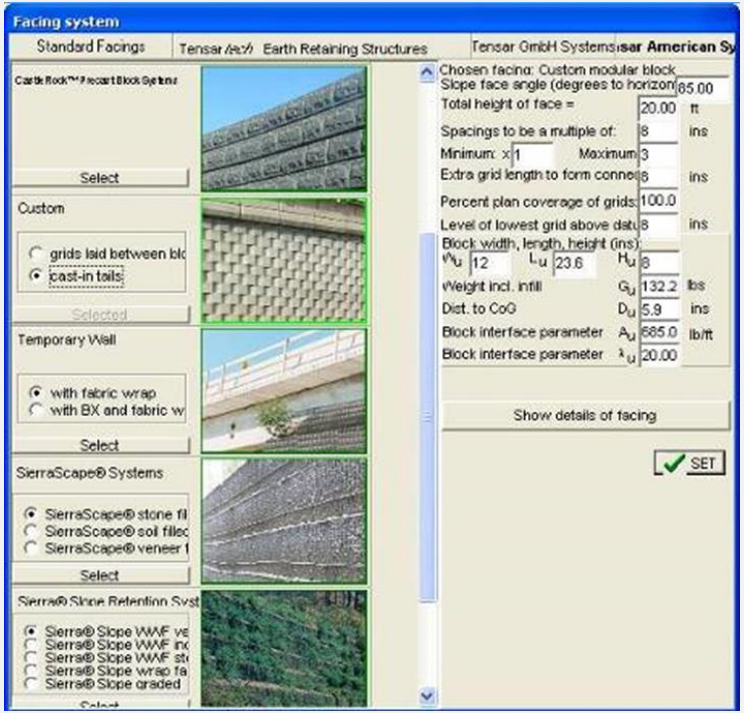
- Different owners, engineers – different expectations
- Some nuances between the two, but in general the design approach is the same
- Load/resistance factors for LRFD will inherently yield a more conservative design compared to NCMA

Design Tools – TensarSoil

- MSE structure design software developed by Tensar International
- Currently available at:
  - https://info.tensarcorp.com/tensarsoil-software-solution
- TensarSoil includes North American Design Standards:
  - FHWA Demo 82
  - FHWA NHI/AASHTO 2002
  - AASHTO LRFD
  - NCMA

Design Tools – TensarSoil

TensarSoil Includes all Tensar grade separation systems



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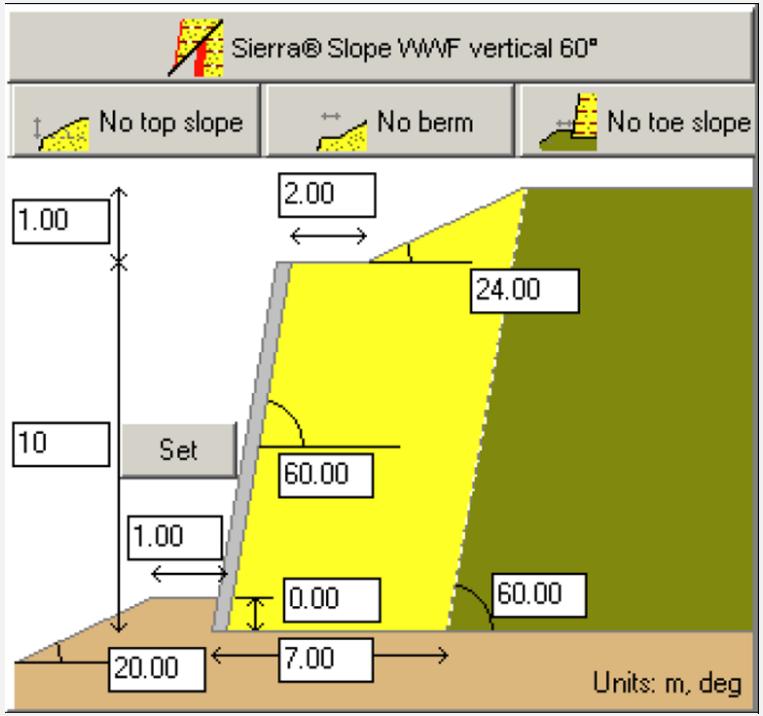
Design Tools – TensarSoil

Geometry is easy to set up



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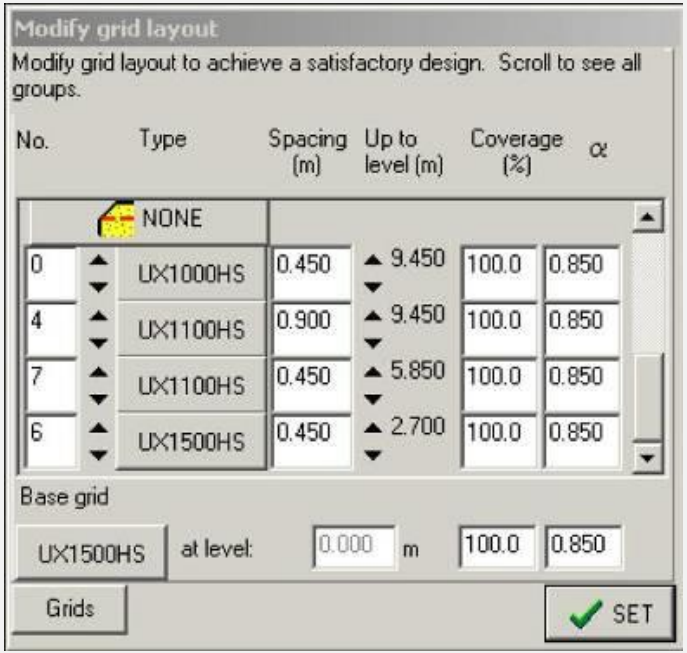
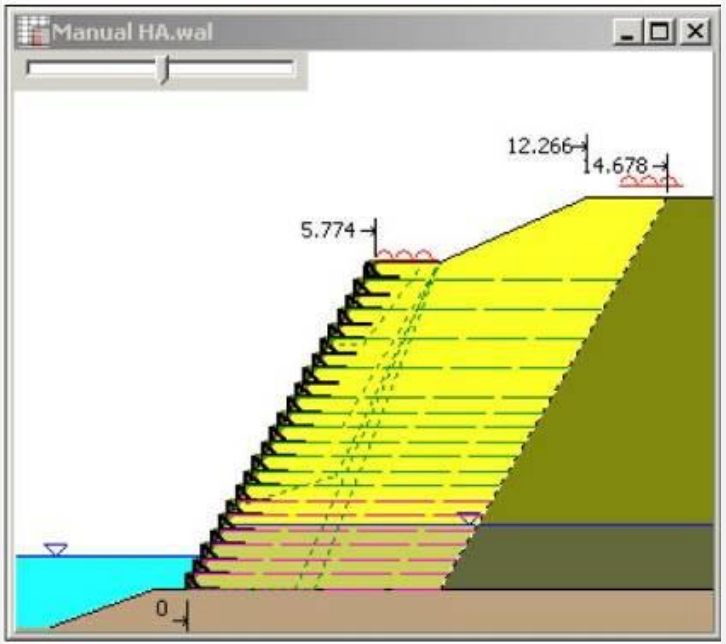
Design Tools – TensarSoil

Geogrid extents and material properties have their own input page and seismicity, hydrostatic forces, and other loading conditions can all be modeled





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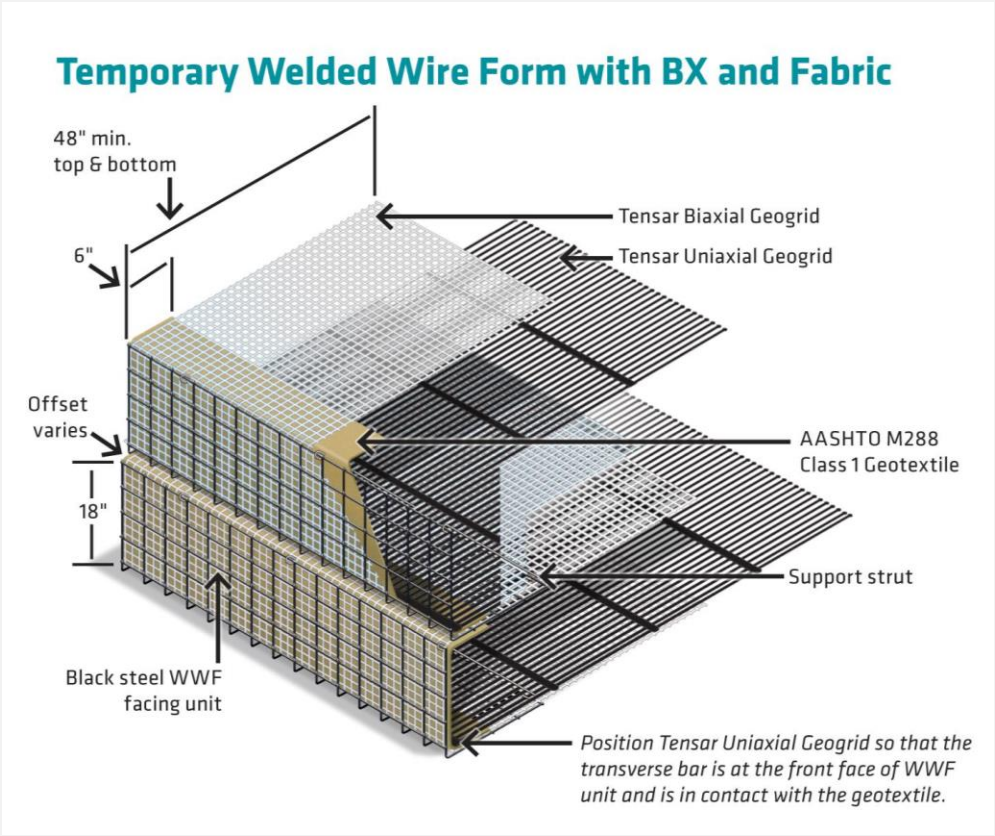
Installation and System Components

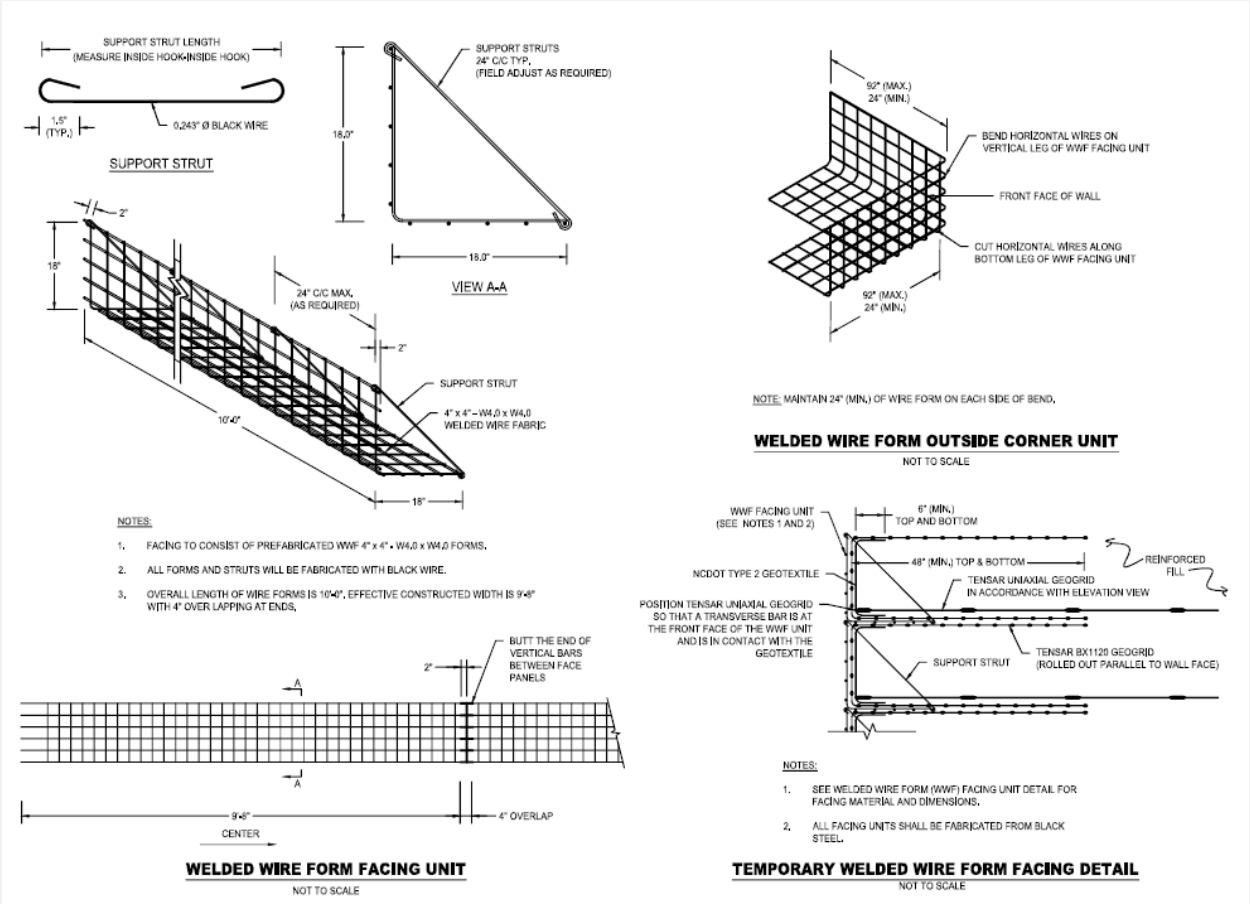
Installation – Temporary Retaining Wall System

Installation – Temporary Wall System

- The Temporary Wall System combines Tensar Geogrids with a **welded-wire form** (galvanized or black steel with struts) for a dependable, cost-effective solution to the most challenging temporary wall projects
- Tensar **Biaxial geogrids** and **AASHTO M288 Class 1 geotextile** are used to create a geosynthetic **wrap** behind the wwf
- Tensar **UX Geogrids** serve as primary reinforcement for the MSE structure
- Offers exceptional performance in areas where seismic activity or heavy external loads are a concern
- Eliminates surficial stability problems often associated with other structures

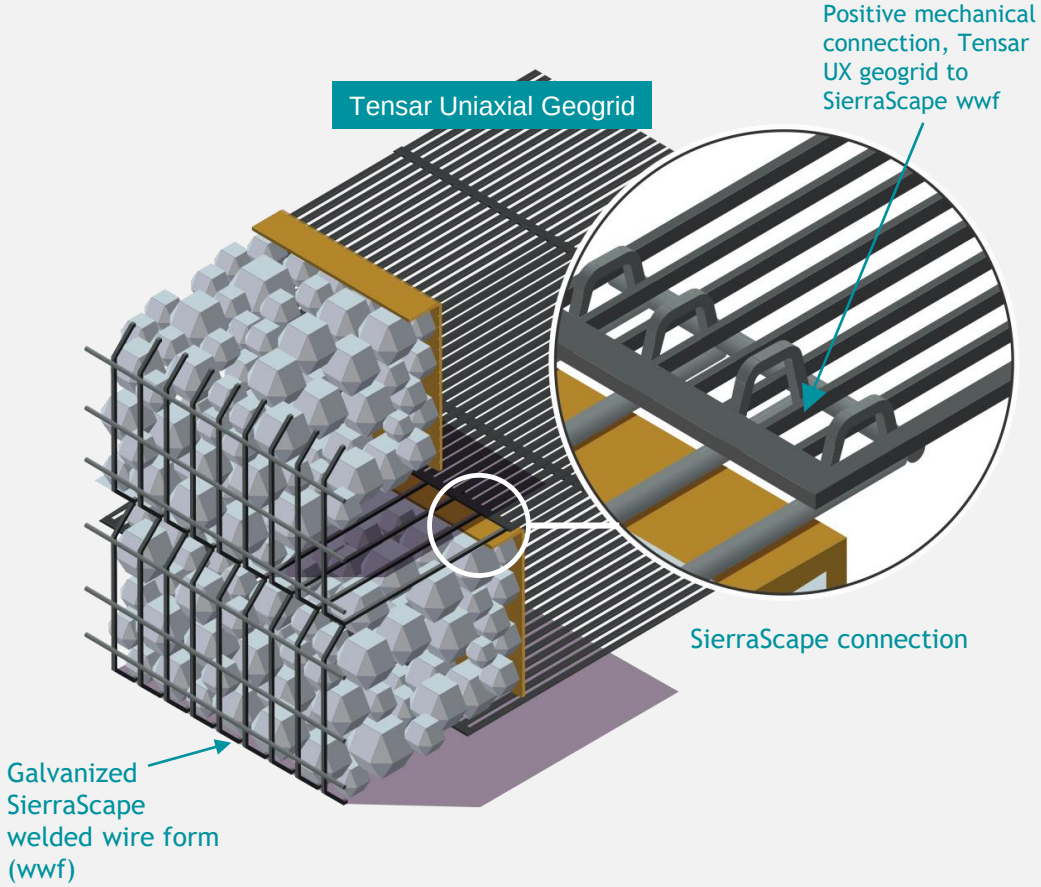


Welded Wire Form Details



Installation – Pressure Relief Wall System

- The SierraScape System combines Tensar **UX Geogrids** with a positive mechanical connection between the geogrid and the **SierraScape welded-wire form** for a dependable, cost-effective solution to the most challenging grade change projects
- This positive mechanical connection better withstands differential settlement
- Offers exceptional performance in areas where seismic activity or heavy external loads are a concern
- Eliminates surficial stability problems often associated with other structures



Installation - Uniaxial (UX) Geogrid

- Primary reinforcement
- Tensile strength in one direction
- High strength at low strains (no preload required)
- HDPE – High-Density Polyethylene (inert in recycled concrete and hot soils)

Installation - Chemical Properties for Backfill Consideration

Soil Properties:	STEEL	PET	HDPE
Saline Soils	X	√	√
pH Lower Limit	5	5	3
pH Upper Limit	10	8	12
Chloride ≥ 100 ppm	X	√	√
Sulfate ≥ 200 ppm	X	√	√
Calcareous Soils	X	X	√
Acid Sulfate Soils	X	√	X
Recycled Concrete	X	X	√
Lime/Cement Treated	X	X	√

Source: FHWA- NHI -00-044 Publication

Logistics Advantages - Freight

Up to 1500 baskets/truck
21,000 SF of wall face

Typically about 500 blocks/truck
500 SF of wall face

- 1 truck/21,000 SF vs. 42 trucks/21,000 SF
- Lower delivery costs
- Less time and space required for unloading and staging

Logistics Advantages – Required Staging Space

40-50 Blocks per Pallet
@ 600 SF of facing pictured

150 baskets per bundle
@ 9000 SF of facing pictured

Logistics Advantages – Lightweight, 2.5 psf vs. 80 psf

1 SierraScape Form
35 lbs.
14 SF

1 SRW Block
80 lbs.
1 SF

- 2 SierraScape forms (70 lbs.) = 1.1 tons of SRW Blocks
- For a 2000 SF wall, 80 lb. blocks will be lifted, placed, and leveled 2000 times
- For the same wall, 35 lb. SierraScape forms will be lifted, placed, and leveled 143 times

Project Profiles

I-76 Summit County, ODOT

PROJECT
ODOT 163003 Summit Co, I-76 Design-Build

LOCATION
Cities of Norton and Barberton, Ohio

APPLICATION
Temporary Retained Earth Wire Wall

INSTALLATION DATE
October 2016

PROJECT DETAILS
A Tensar Temporary retained earth wall was chosen to assist in the staged construction of bridge spans over Wolf Creek in Summit County. The team of Kenmore Construction, ODOT, AECOM, Thrasher Engineering and PS Construction Fabrics was able to go from proposal to stamped design to delivery of all the materials in a two week period. The quick turn around was key in the utilization of Tensar's Temporary Retaining Wall System on this design-build project.

SR 91 and Norton Road, Stow, OH

PROJECT
Stow / SUM-91-11.83
SR 91 & Norton Rd. (Part 2)

LOCATION
Stow, Ohio

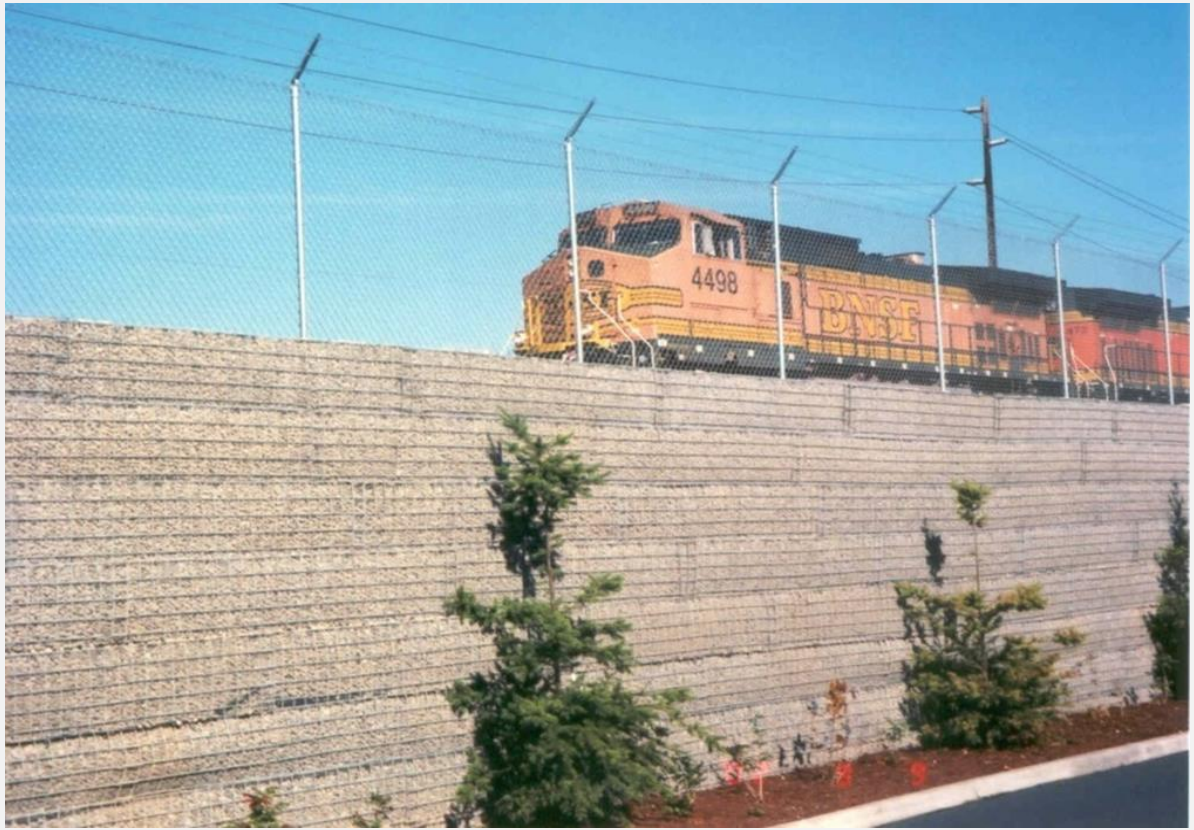
APPLICATION
Temporary Wall for Phased Highway Construction

PRODUCT
Black Steel SierraScape Baskets, BX1120, UX1400, UX1500, Non-Woven Geotextile

INSTALLATION DATE
July – October 2016

PROJECT DETAILS
The SierraScape wall system was utilized to construct a temporary earthen wall, facilitating construction of a reinforced culvert to replace a twin span bridge over the Summit County Metropark's Towpath Trail. One span was demolished and the culvert and wall were installed to allow the embankment to be placed for the new section of roadway. The second span could then be demolished and the fill completed to allow all lanes of SR 91 to be restored.

Temporary Wall – E-80 Loading



SR76 San Diego, CalTrans

The Challenge:

- Develop a series of embankments to support bridges for the heavy haul earthwork traffic over the SR-76 widening project in Southern California

The Solution:

- Temporary wall structures (designed to be true abutments) to support the bridge and CAT 777 haul traffic using AASHTO bridge design specifications
- This solution was chosen by CalTrans over other alternatives based on economy and ease of construction

PROJECT HIGHLIGHTS

Project:
SR-76 Temporary Bridge

Location:
Bonsall, San Diego County, California

Installation:
May – June 2010

Product/System:
Tensar® BX and UX Geogrid
Tensar® Temporary Wall System

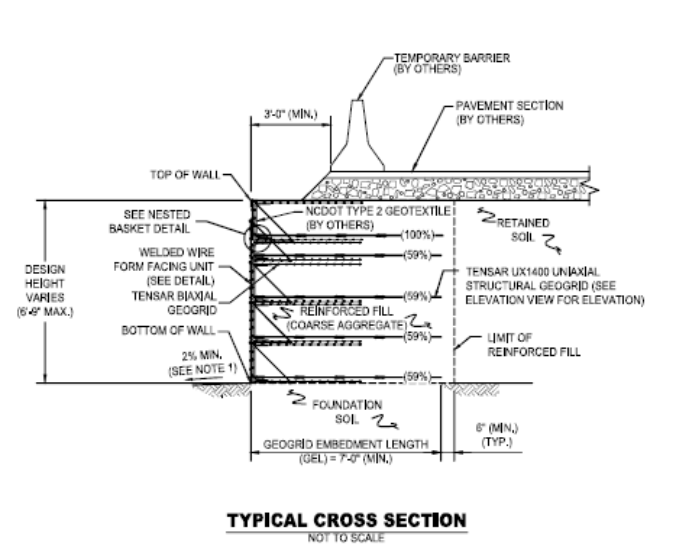
Quantity:
2,000 square yards

Owner/Developer:
Caltrans

A CAT 777 weighing approximately 360,000 lbs is supported by a Tensar Temporary Wall as it drives to the embankment site.

Tensar was able to create true abutments with the ability to handle very large surcharge loads.

Temporary Wall – I-77 Express Lanes, NCDOT



- Temporary walls used to reroute traffic lanes around complex interchange improvements
- Immediate availability of the integrated design and system components
- Installation simplicity
- Other applications of the system were developed as VE to means and methods

Temporary Wall – I-77 Hot Lanes, NCDOT

- Additional temporary walls were used in another location several miles North of the phased traffic temporary walls
- The temporary walls in this location provided the Design/Build team with a new work zone access location from a flyover ramp, eliminating miles of haul for aggregate delivery.
- The access ramp was demolished within ~24 months of service after providing a significant VE solution using temporary walls for site access.

Temporary Wall – Surcharge Loading, Philadelphia Airport

Example Projects – Pressure Relief Walls

University of Virginia, John Paul Jones Arena

University of Virginia, John Paul Jones Arena

- SierraScape® Pressure Relief Walls followed irregular wall alignment requirements
- Wrapped in fabric to accommodate backfill with fines
- Gap allowed for slight movement as well as room for drainage structures and communication duct banks
- Reinforced zone designed to support 90,000 lb. column loads behind face of SierraScape wall

University of Virginia, John Paul Jones Arena

Campbell's Soup Facility, Napoleon, OH

Campbell's Soup Facility, Napoleon, OH

- SierraScape® Pressure Relief Walls built to remove lateral earth loads from basement freezer addition
- Wrapped in biaxial geogrid to confine readily available DOT roadway stone
- 6" gap set back from 4" foam insulation allows for drainage and a confined air space, increasing insulation performance
- Wall designed to support surcharge live loads, allowing equipment to travel on reinforced zone above wall

Razorback Stadium –North End Zone Expansion

Razorback Stadium –North End Zone Expansion

Two-Stage Walls

Stacked-Stone Facade

Permanent Structures

References for More Info

- Tensar Website and Blog – www.tensarcorp.com
- Your Local Tensar Regional Manager or Distributor
- John Bolton - jbolton@tensarcorp.com

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