

# BUILDING BETTER ROADS

**Geosynthetic Stabilized Paved and Unpaved Roads**  
**Brendon Stieb**

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# AGENDA

- Why Roads Fail
- Understanding the Foundation
- Why Use Geosynthetics
- How Geogrids Work
- History and Research
- Case Histories

# WHY ROADS FAIL



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# COMMON DISTRESSES IN UNPAVED ROADS

- Permanent rutting
- Excessive maintenance requirements
- Loss of aggregate into weak subgrades
- Wet-weather instability
- Reduced ride quality and accessibility



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# COMMON DISTRESSES IN PAVED ROADS

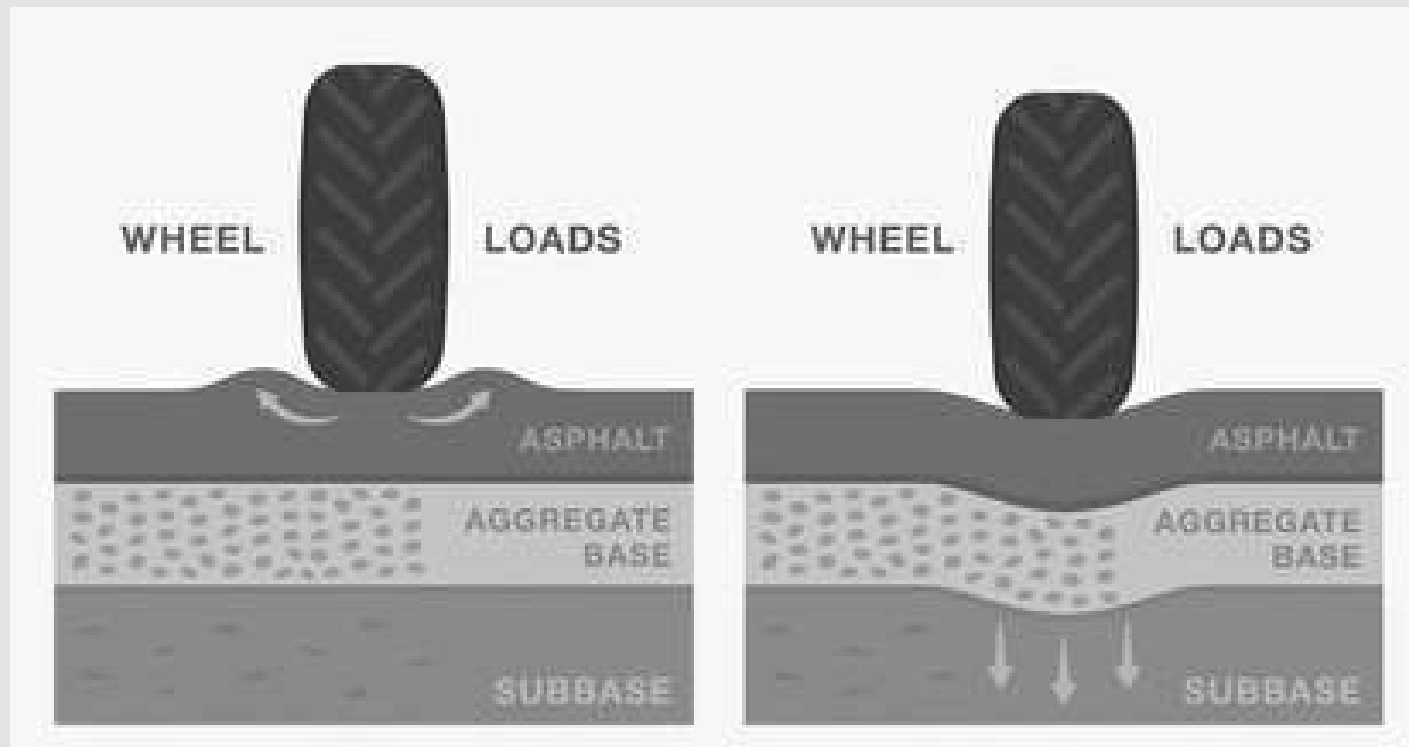




“ROADS WEAR  
OUT FROM THE  
TOP DOWN, BUT  
THEY FALL  
APART FROM  
THE BOTTOM  
UP”

**National Association of  
County Engineers**

# RUTTING VS. STRUCTURAL FAILURE



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# MOST ROAD PROBLEMS START BELOW THE SURFACE

- Surface distress is often the symptom, not the cause.
- Foundation conditions drive long-term performance.
- Measuring and understanding subgrade support is the first step toward effective road design.

# UNDERSTANDING THE FOUNDATION



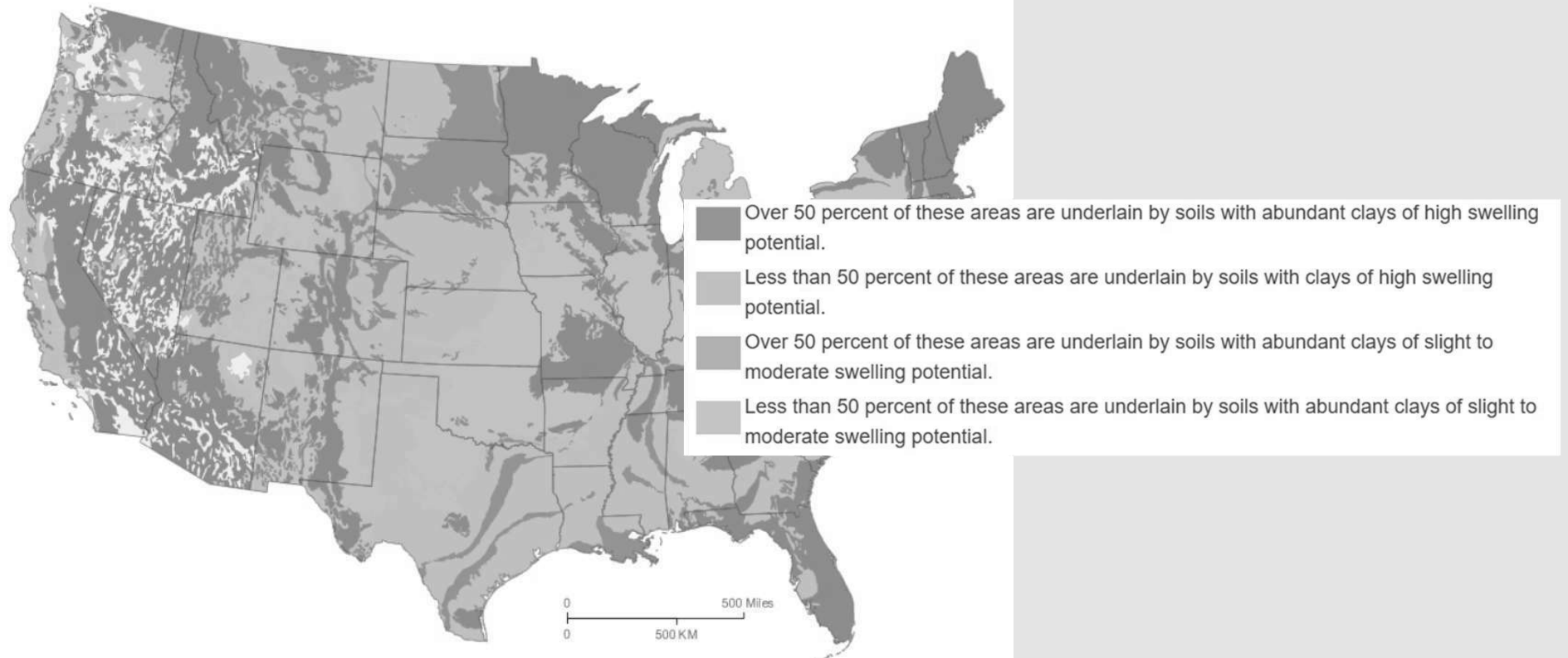
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# UNDERSTANDING THE FOUNDATION

- Geotechnical Reports
  - CBR Testing
  - Unconfined Compression Testing
  - Atterberg Limits
  - Moisture-Density Relationships
- Boring Logs
  - Soil Stratification
  - Groundwater Conditions
  - Soil Variability
- Field Testing/Verification
  - DCP Testing
  - Automated Plate Load Testing



# UNDERSTANDING THE FOUNDATION

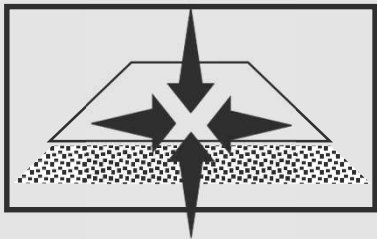


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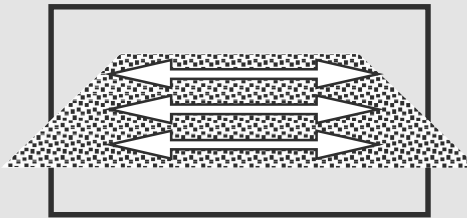
# WHY USE GEOSYNTHETICS

- Increasing traffic demands
- Poor native soil conditions
- Aggregate availability and cost/aggregate quality
- Need for improved long-term performance
- Desire for more efficient designs

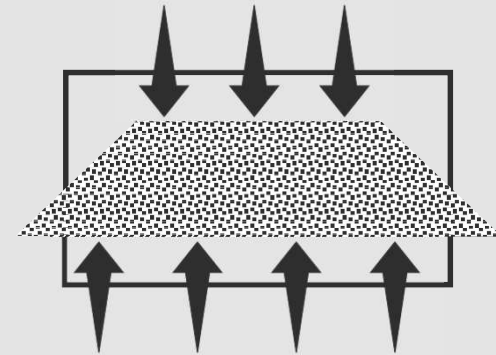
# GEOSYNTHETICS FUNCTIONS



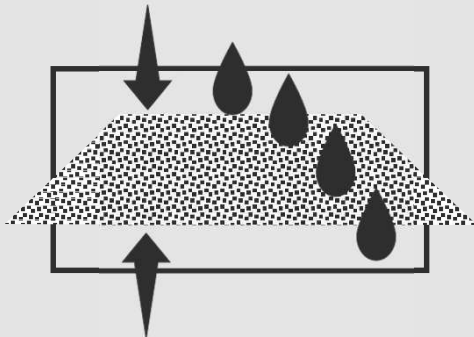
**1** Stabilization



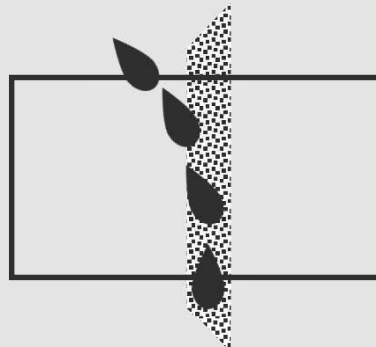
**2** Reinforcement



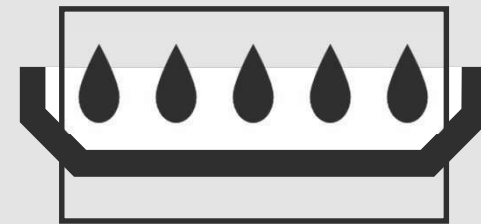
**3** Separation



**4** Filtration

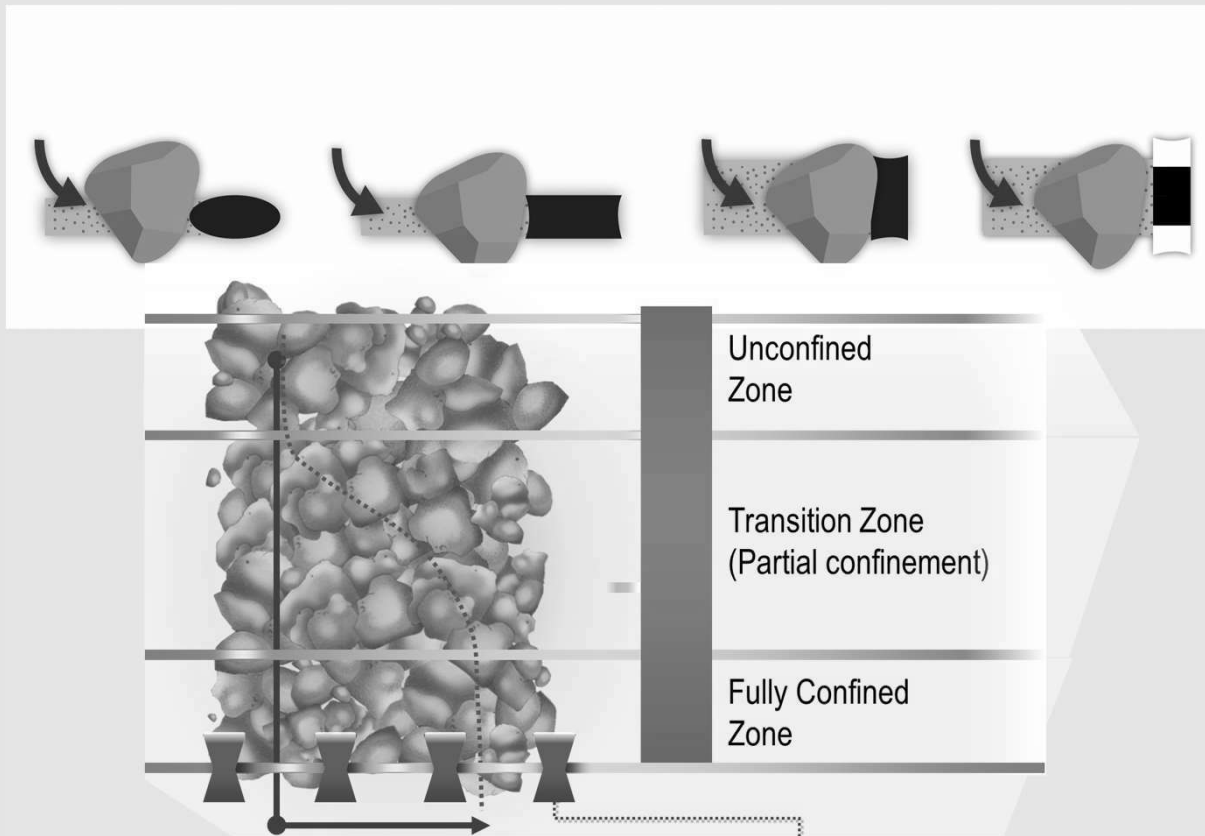


**5** Drainage



**6** Containment

# WHY GEOGRID – AGGREGATE INTERLOCK

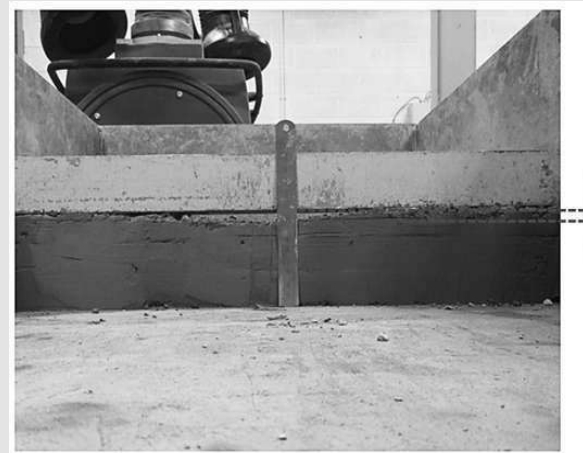


# WHY GEOGRID - IMPROVED BEARING CAPACITY



# WHAT DOES THIS MEAN FOR THE ROAD

- **Reduced Rutting**
  - Less aggregate movement
  - Less subgrade deformation
- **Increased Structural Capacity**
  - Improved aggregate layer performance
  - Better load carrying ability
- **Improved Trafficability**
  - Better construction access
  - Better unpaved road service
- **Extended Service Life**
  - Reduced maintenance frequency
  - Improved pavement support

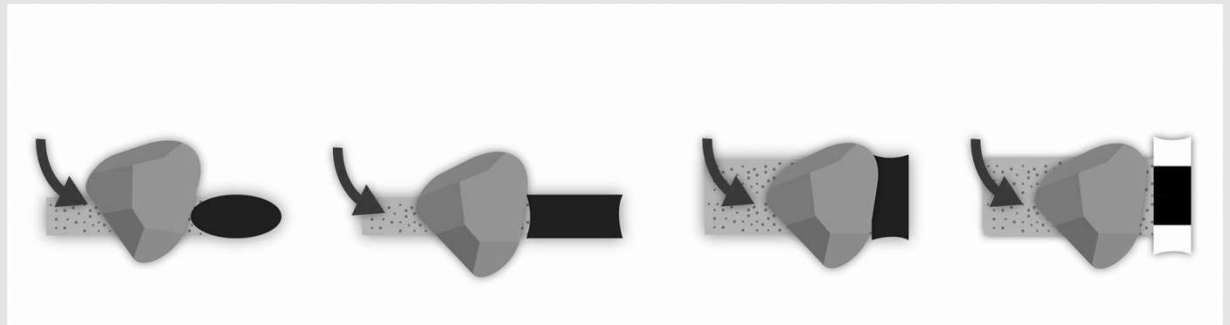


# FIELD OBSERVATION



# EVOLUTION OF GEOGRID PERFORMANCE

- Early projects demonstrated improved trafficability and reduced rutting.
- Initial adoption was driven largely by field success.
- Research efforts sought to understand why improvements were occurring.
- **Today's design methods are increasingly based on quantifiable performance benefits.**



# EVOLUTION OF GEOGRID PERFORMANCE

- Tensile reinforcement was often viewed as the primary benefit.
- Tensioned membrane theory was frequently used to explain performance.
- Benefits were thought to be limited primarily to very weak subgrades.
- Most roadway applications experience relatively small geogrid strains.
- Aggregate confinement plays a much larger role than once believed.
- Benefits extend across a broad range of subgrade strengths.

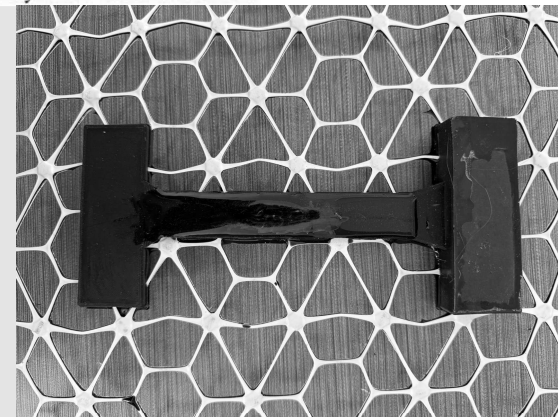
**Geogrid Requirements**

| Property                      | Test Method            | Specifications <sup>(1)</sup>                     |
|-------------------------------|------------------------|---------------------------------------------------|
| Minimum opening size          | N/A <sup>(2)</sup>     | ½ in (13 mm)                                      |
| Maximum opening size          | N/A <sup>(2)</sup>     | 3 in (75 mm)                                      |
| Tensile strength at 2% strain | ASTM D6637             | 400 lb/ft (5.8 kN/m)                              |
| Tensile strength at 5% strain | ASTM D6637             | 800 lb/ft (11.7 kN/m)                             |
| Ultimate tensile strength     | ASTM D6637             | 1300 lb/ft (19.0 kN/m)                            |
| Junction strength             | GRI <sup>(3)</sup> GG2 | 25 lb (110 N)                                     |
| Ultraviolet stability         | ASTM D4355             | 50% retained strength after 500 hours of exposure |

(1) Strength values are in the weaker principal direction.

(2) Direct measure with caliper.

(3) Geosynthetic Research Institute.



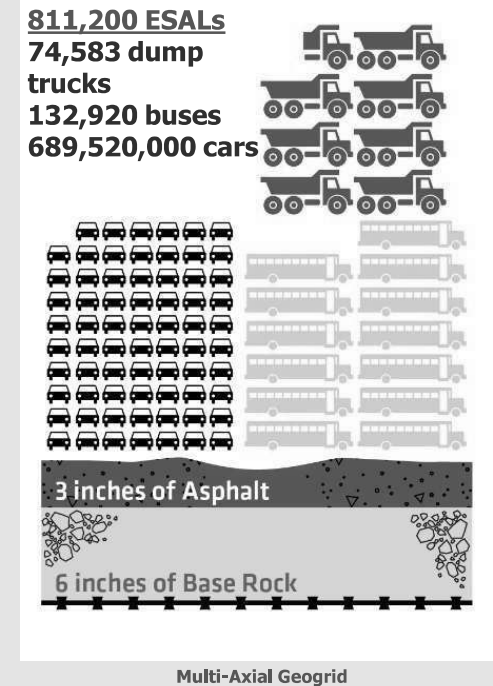
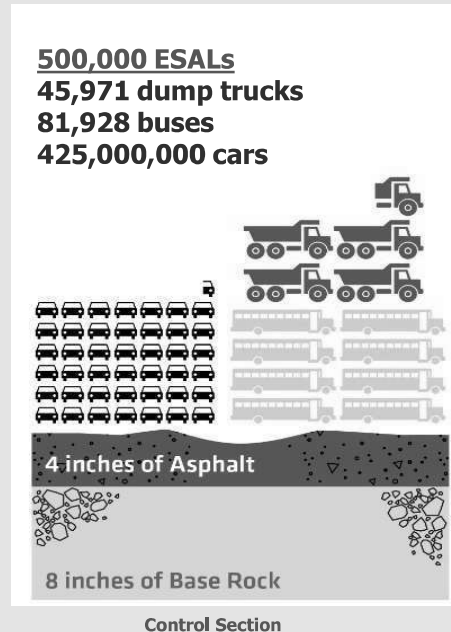
# WHAT ACCELERATED PAVEMENT TESTING SHOWED

## Key Findings

After 800,000+ ESALs, thinner geogrid stabilized sections, over stiff subgrade soils, had less than half as much rutting as the control.

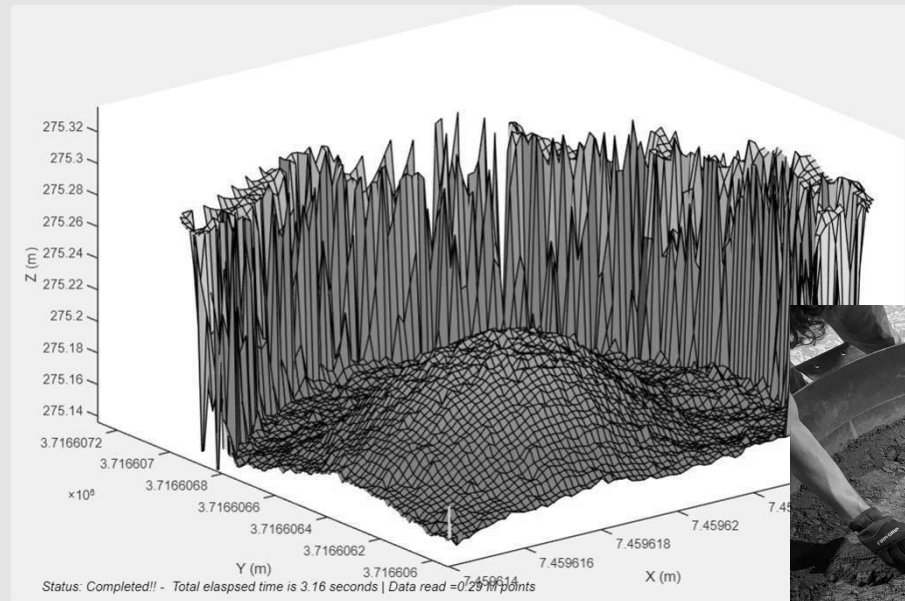
Structural benefits of Tensar geogrids exceeded design values.

Estimates show Tensar geogrid provides ~16% savings in construction costs, ~19-25% improvement in performance (>60% improvement in this testing) and a savings in time of ~5.5 days per lane mile.



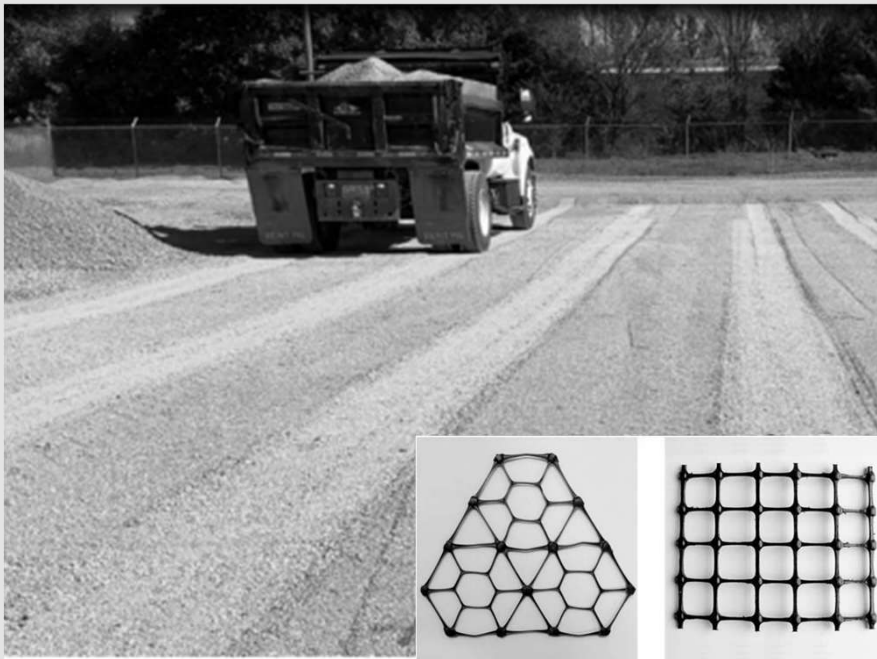
# LABORATORY RESULTS AND FIELD RESULTS

- Approx. 18% - 20% less vertical rise with one layer of high performing multi-axial
- Approx. 30% less vertical rise with two layers of high performing multi-axial
- Unstabilized aggregate lose stiffness and unraveled, especially at 8" thick section, after a number of cycles
- Stabilized section more resilient to shrink/swell cycles – maintained integrity due to mechanical stabilization

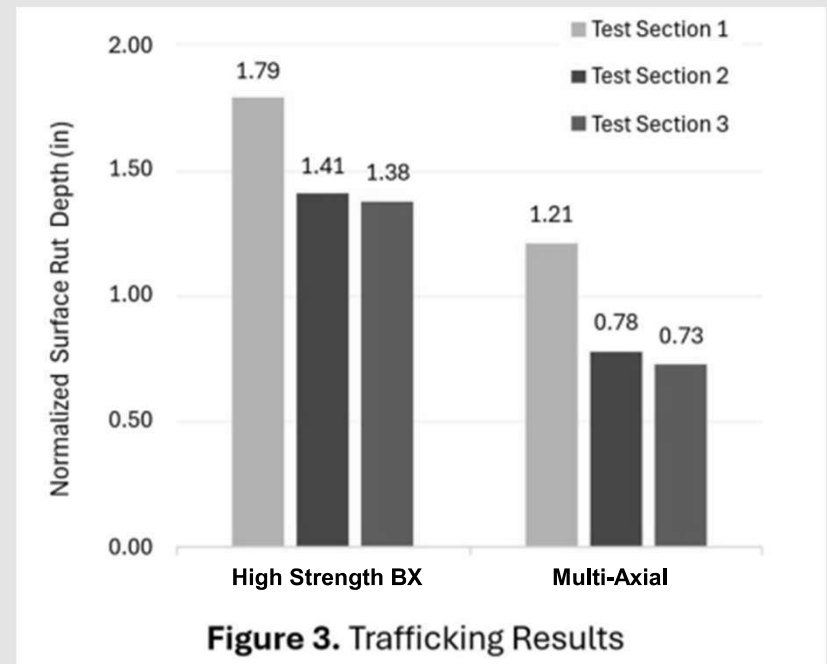


# LABORATORY RESULTS AND FIELD RESULTS

## STANDARD PROOF ROLL OPERATION



## UP TO 41% LESS RUTTING IN MULTI-AXIAL



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# WHAT RESEARCH CONSISTENTLY SUPPORTS

- Geogrids reduce lateral aggregate movement
- Geogrids improve aggregate confinement
- Geogrids reduce rutting
- Geogrids improve structural performance of aggregate layers
- Benefits can be incorporated into modern design methodologies

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# STABILIZATION STRATEGY

## UNDERSTAND THE NEED

- Mechanism of failure drives solution
  - Weak Subgrade
  - High Plasticity Soils
  - Heavy Long-Term Loading
  - Construction Traffic
  - Poor Quality Aggregates

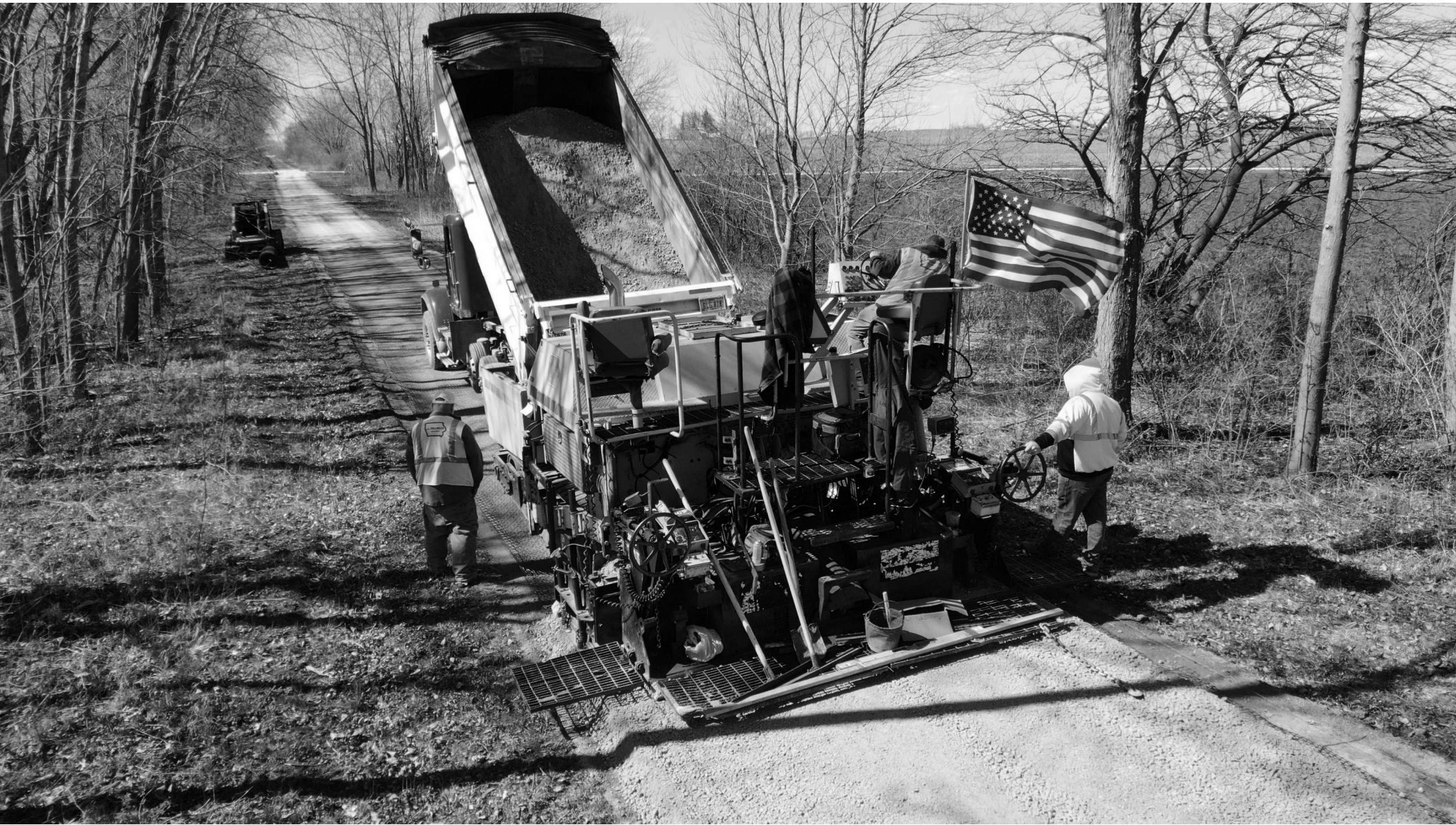






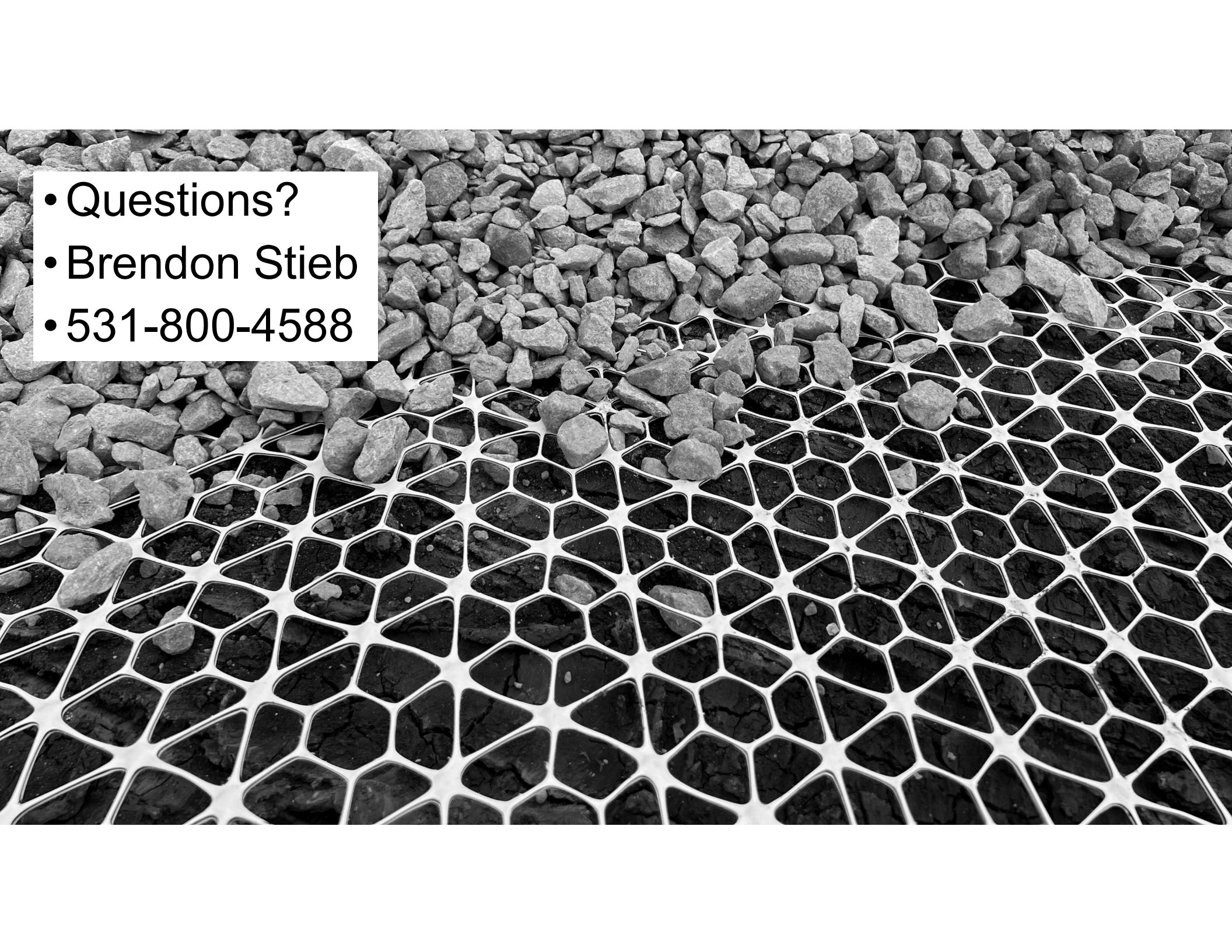










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- Questions?
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