Geotextiles for Base Reinforcement

by

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Idaho Falls, Idaho

South Dakota Local Transportation Assistance Program (SD LTAP)

The Connection

Between Transportation Technology and Local Government

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If You Can't Drain It — You Can't Maintain It!

This article will focus on one of the fundamental issues in construction and maintenance. That issue is establishing and maintaining good drainage on our streets and roadways. This is an opportune time to deal with some of the difficult maintenance issues with drainage. Most of South Dakota is in moderate to severe drought conditions. While that is not good, it does provide the opportunity to do ditch and channel cleaning in relatively good working conditions. It certainly is better than trying to dewater or clean ditches with standing water in them. We will comment on these specific issues related to drainage:

- Establishing or restoring ditch elevations
- Maintaining inlets/outlets on storm sewers
- Inspecting culvert ends for damage/obstruction
- Inspecting channels at pipe/structure locations.
- Basic surface drainage issues on pavement and gravel roads

Ditch Elevations

Siltation due to wind and water erosion must be addressed periodically to maintain flow lines, direction of flow and pipe capacity. A 36" pipe silted half full will result in significantly higher water at the inlet during a "design flood." If there is shallow cover over the pipe, water may overtop the road. This situation in hours of darkness could be hazardous. Not only is ditch drainage important for the roadway section but also for safety. This is especially important in areas of housing or industrial development which have less infiltration and more runoff.

This road has a ditch badly filled with silt on the left and water overtopped in a recent storm.

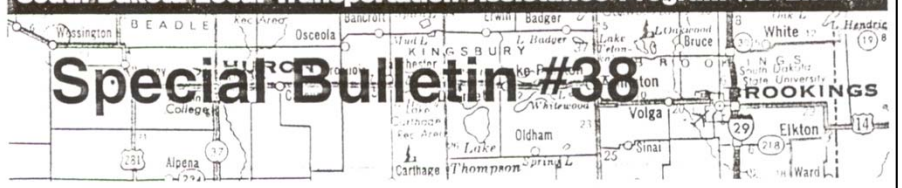
Closeup view of culvert inlet almost completely buried under heavy silt and vegetation.

Storm Sewers

Inlets become plugged with vegetation, cans, bottles and a variety of other floating objects. As drainage bypasses the inlet and the storm drainage continues downstream, the accumulation may exceed the capacity of the lowest inlet resulting in flooding. The adjacent business or homes may be damaged due to lack of drainage maintenance. Storm sewer outlets may need erosion protection if the gradient is steep resulting in high velocity. We need to establish good drainage, but "*after you drain it, maintain it*" is another good slogan. As noted in the above paragraph, as adjacent areas develop and runoff increases, drainage maintenance becomes even more critical.

Continued on next page

South Dakota Local Transportation Assistance Program (SD LTAP)



Special Bulletin #38

Gravel Road Rehabilitation

Introduction

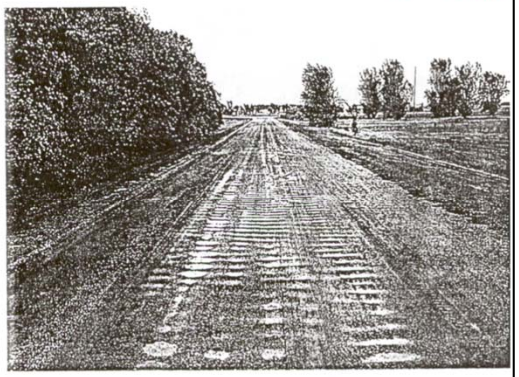
Gravel roads are generally maintained by performing routine blading to maintain a crowned, smooth driving surface. Surface gravel is added as needed either by "spot graveling" or placing fresh gravel on an entire section. Some gravel roads can be maintained for indefinite periods with good blade maintenance and replacing surface gravel as needed.

However, almost any gravel road will gradually begin to show distress that requires more than routine maintenance to correct. If some rehabilitation isn't done, the time and money spent for simple routine blading and adding gravel is all but wasted. The road will never be in good driving condition until the right rehabilitation is done.

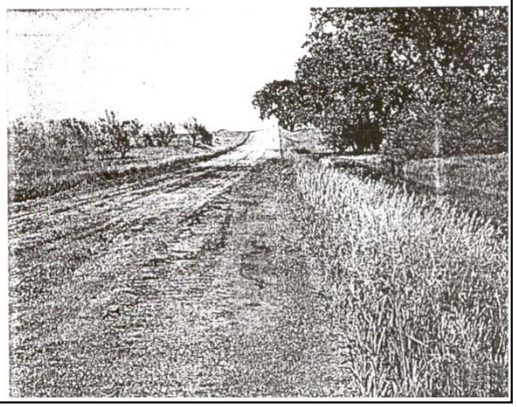
Identify the Problems

Problems can range from simple loss of crown on the driving surface to loss of shape on the entire cross section. The first problem to look for is poor drainage. Drainage is a critical matter on all roads and streets, but it is a particularly serious problem on those with gravel surfaces. When water begins to collect on the road surface, the gravel road will begin to lose shape very quickly. Two major drainage problems are poor crown and the high shoulder or "secondary ditch."

Either of these problems should be corrected quickly since water that collects on the road surface or along the shoulder line will gradually percolate into the surface material and subgrade. When this happens, the road can quickly go out of shape, especially if it is subjected to heavy loads.



The need for gravel road rehabilitation ranges from simple loss of crown and severe washboarding in the photo above to a complete loss of correct shape of cross section in the photo below.



Geosynthetics for Base Reinforcement

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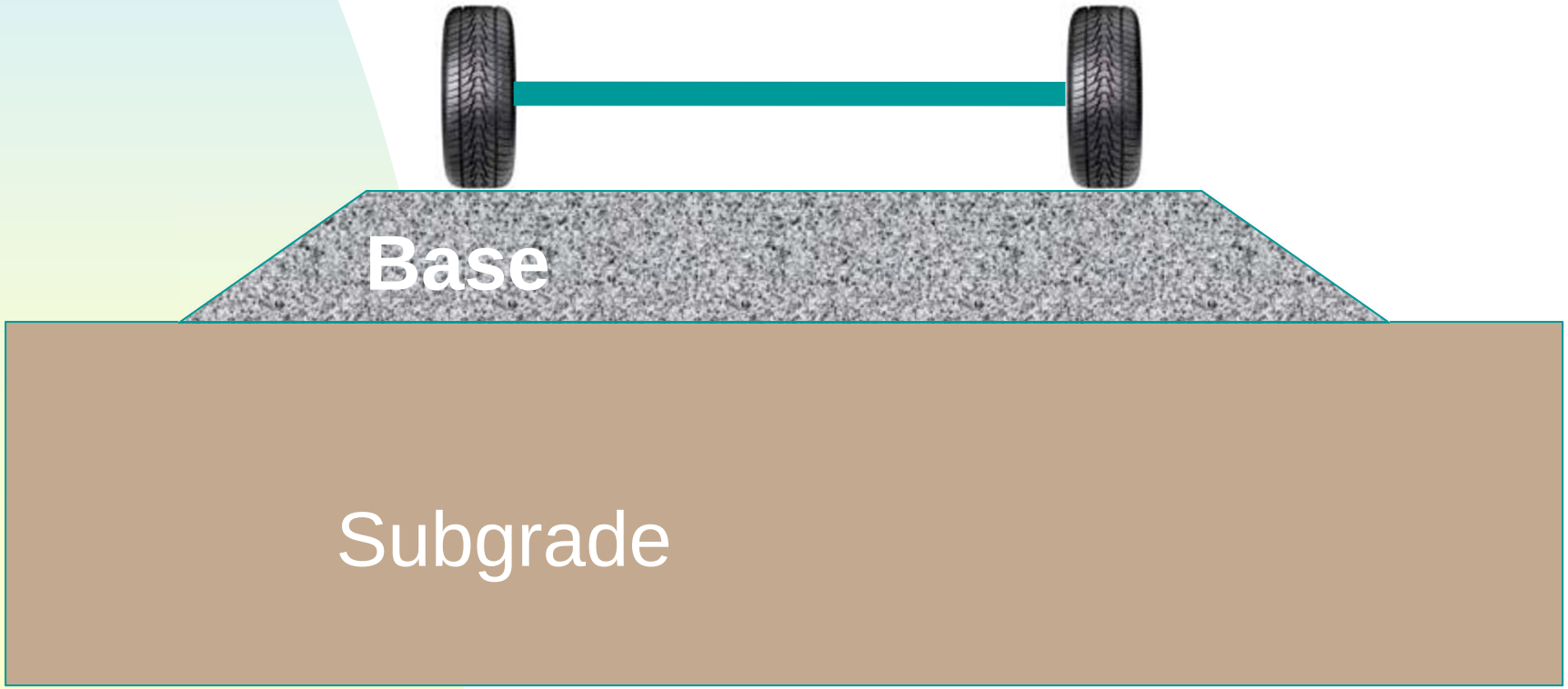
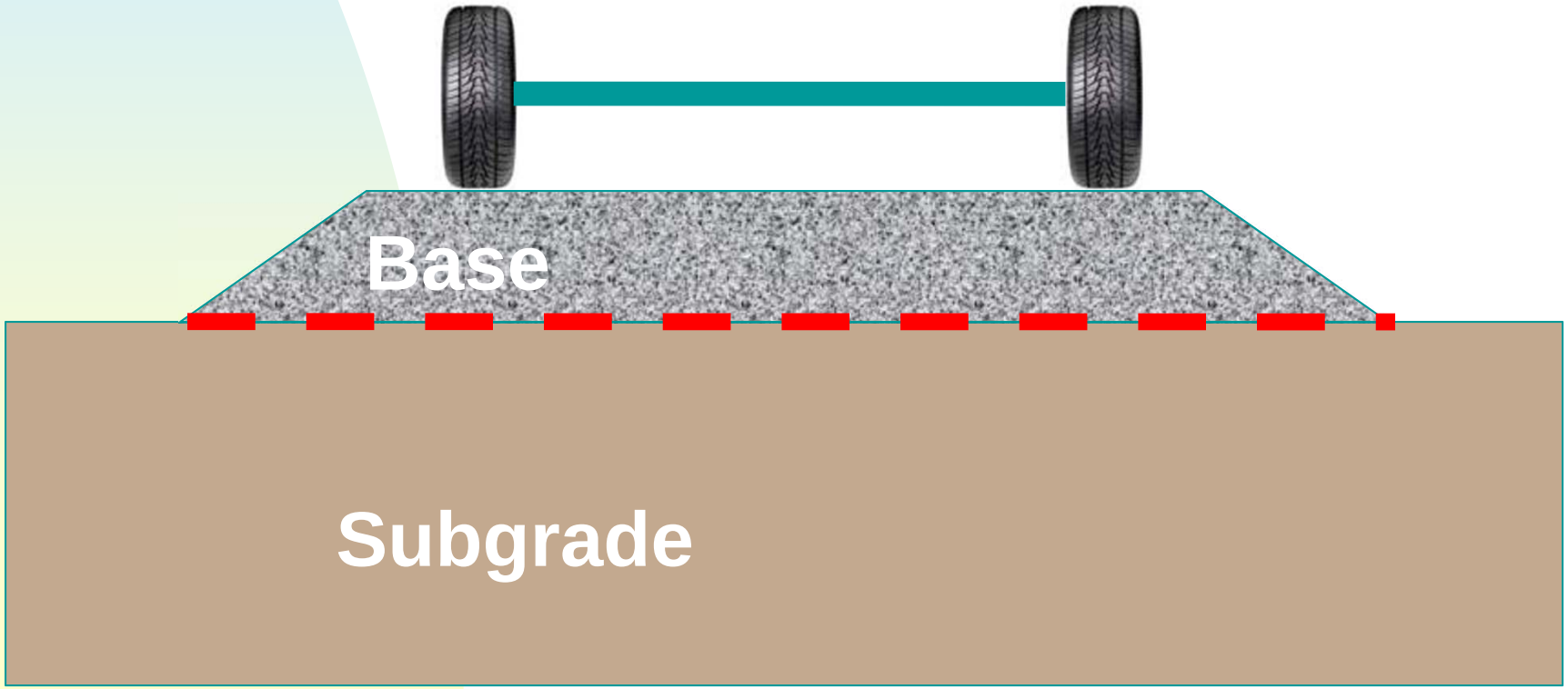
Unpaved Road Without Geosynthetic(s)



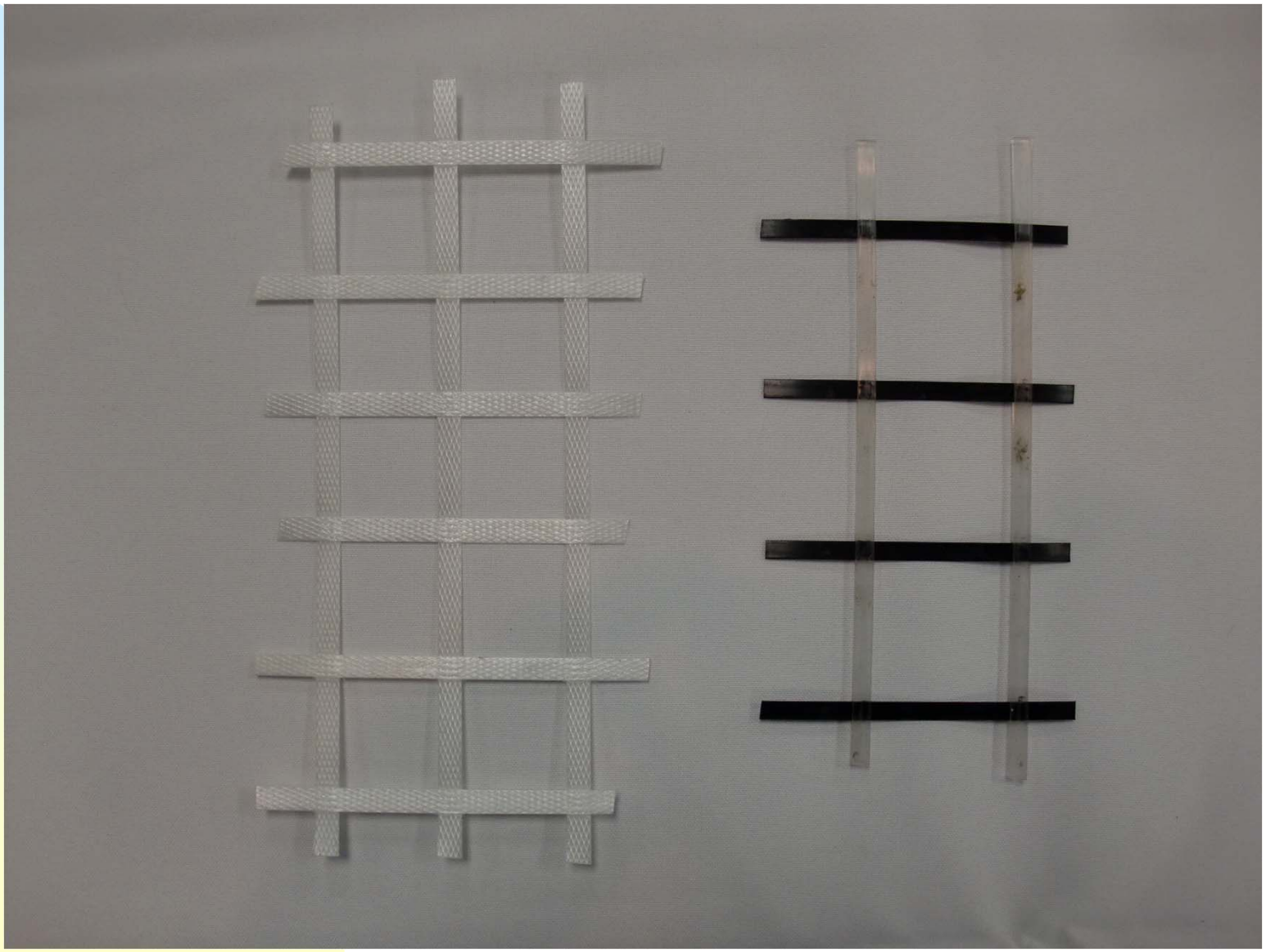
Unpaved Road With Geosynthetic(s)



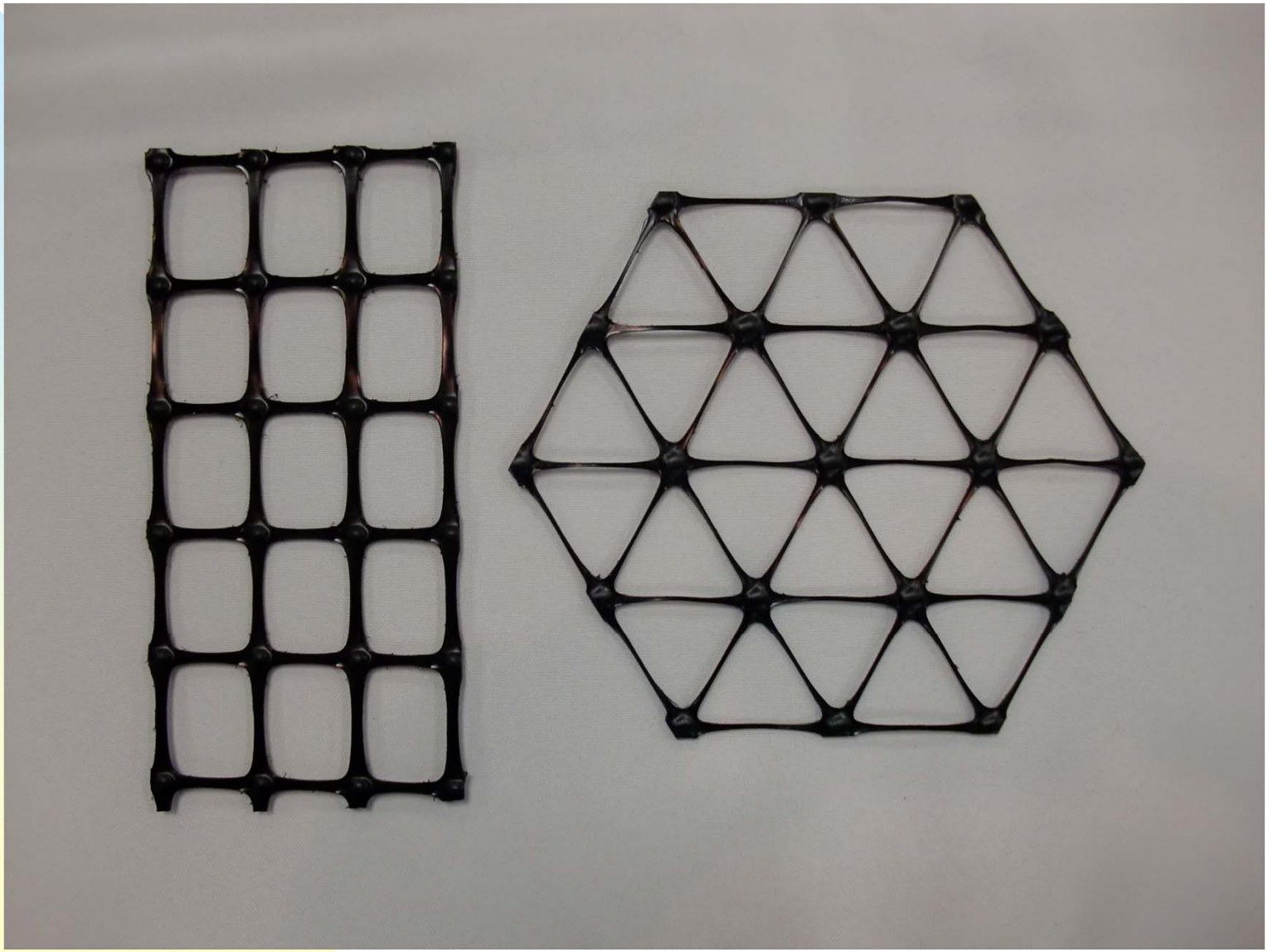
Geotextiles

Geogrids - Woven

Geogrids - Welded



Geogrids – Extruded




30
M.P.H.
ROAD
BREAKUP

…near a livestock feedlot.

…near a commercial dairy.

…during wind tower construction


ROAD CLOSED
SPEED LIMIT 25
MAR 18 2009

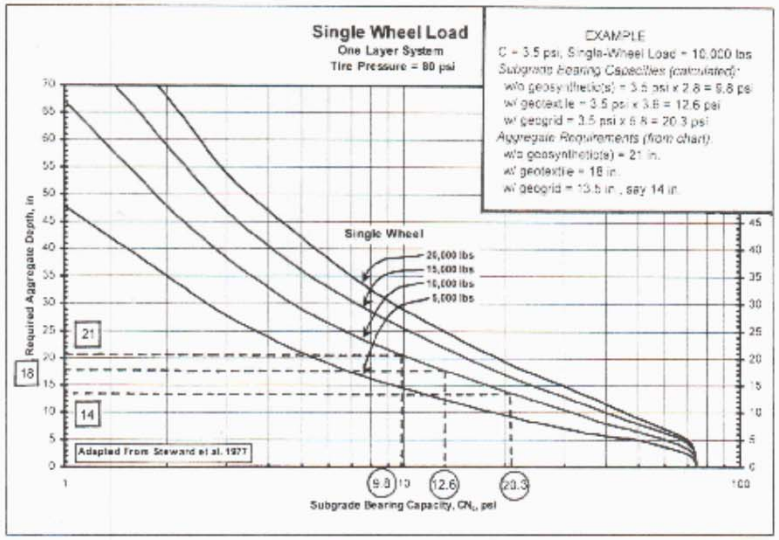
How much cut/agg is enough?

Aggregate Requirements to Support Wheeled Equipment

Soil Strength, C (psi)	Consistency	Field Approximation
< 1.7	Very Soft	Squeezes between fingers when fist is closed; easily penetrated several inches by fist.
1.7 - 3.5	Soft	Easily molded by fingers, easily penetrated several inches by thumb.
3.5 - 6.9	Medium Stiff	Molded by strong pressure of fingers; can be penetrated several inches by thumb with moderate effort.
6.9 - 13.9	Stiff	Dented by strong pressure of fingers; readily indented by thumb but can be penetrated only with great effort.
13.9 - 27.8	Very Stiff	Readily indented by thumb nail.
> 27.8	Hard	Indented with difficulty by thumb nail.

From Oregon DOT Soil and Rock Classification Manual, 1987 (Table 10, page 17)

Under wheeled equipment, ground bearing capacity = C x Nc, where:
C = Soil strength expressed as undrained shear (Cohesion), psf, and
Nc = Bearing Capacity Factor:
Nc = 2.8 w/o geosynthetic(s), 3.6 w/ geotextile & granular fill, 5.8 w/ geogrid & granular fill



From U. S. Army Corps of Engineers "Aggregate-surfaced pavement design curves..." at:
http://140.194.76.129/publications/eng-tech-ltrs/etl1110-1-189/toc.htm (Fig. 5, page 12)

EXAMPLE

Aggregate Requirements to Support Wheeled Equipment

Soil Strength, C (psi)	Consistency	Field Approximation
tween fingers when fist is closed: rated several inches by fist.	<1.7	Very Soft	Squeezes be easily pene
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trong pressure of fingers; can be several inches by thumb with fort.	3.5 - 6.9	Medium Stiff	Molded by s penetrated moderate e
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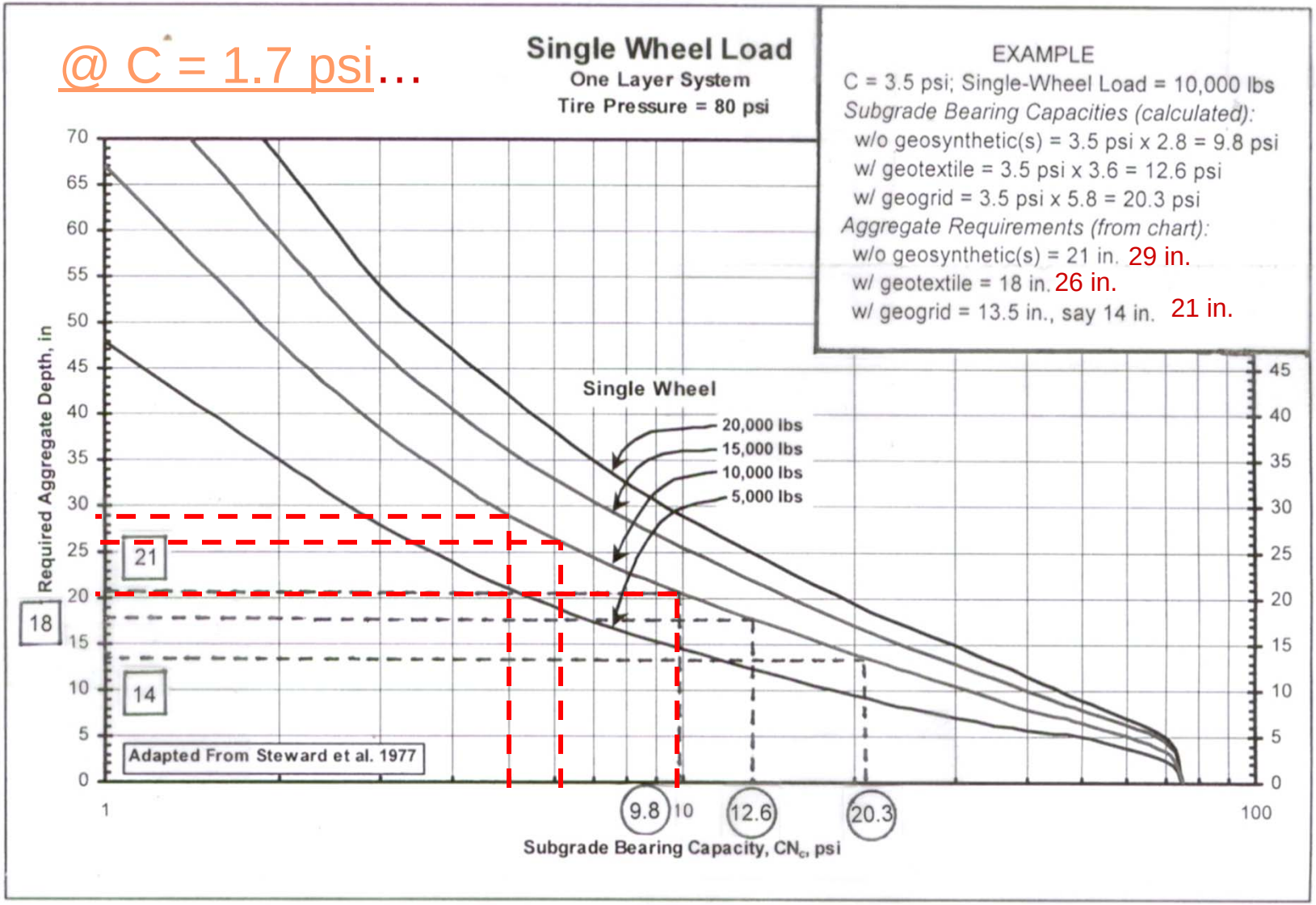
From Oregon DOT Soil and Rock Classification Manu

@ C = 1.7 psi…



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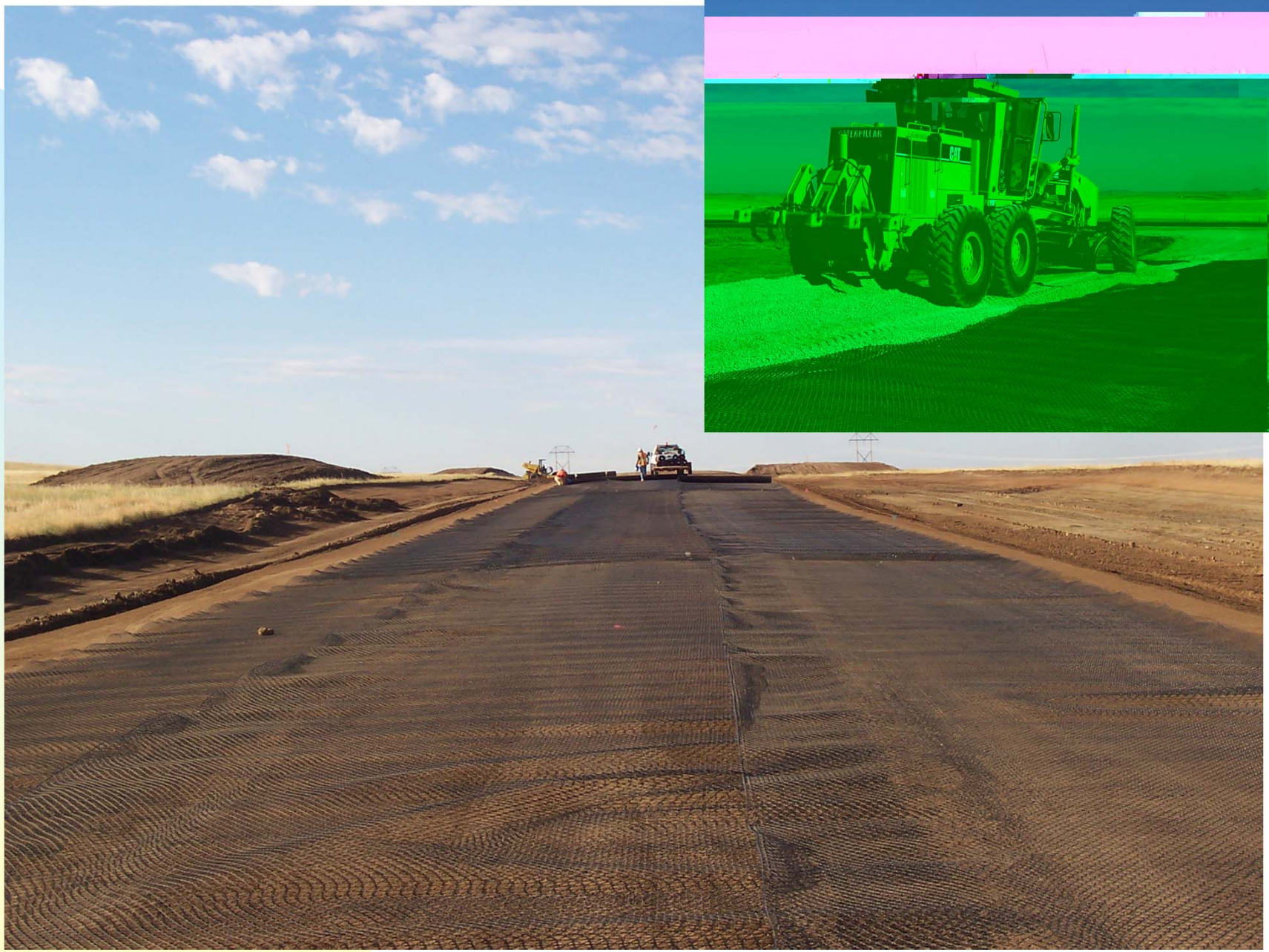
A Typical Thickness Relationship…

What About Separation?


CATERPILLAR
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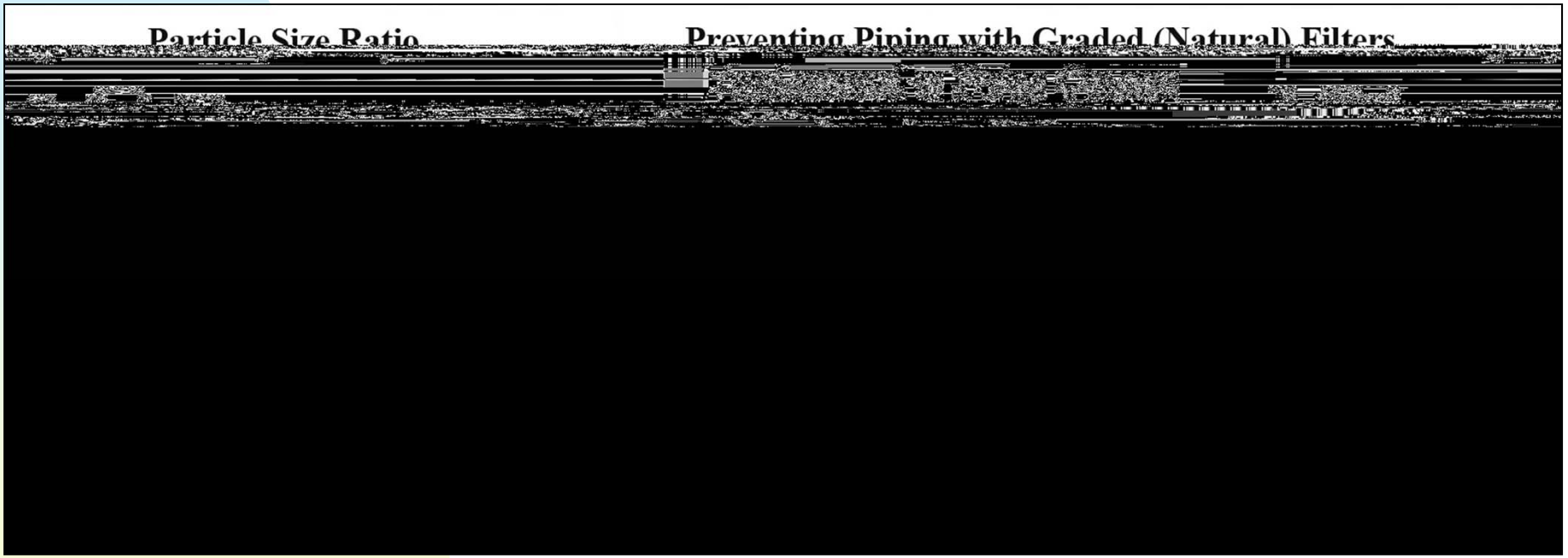
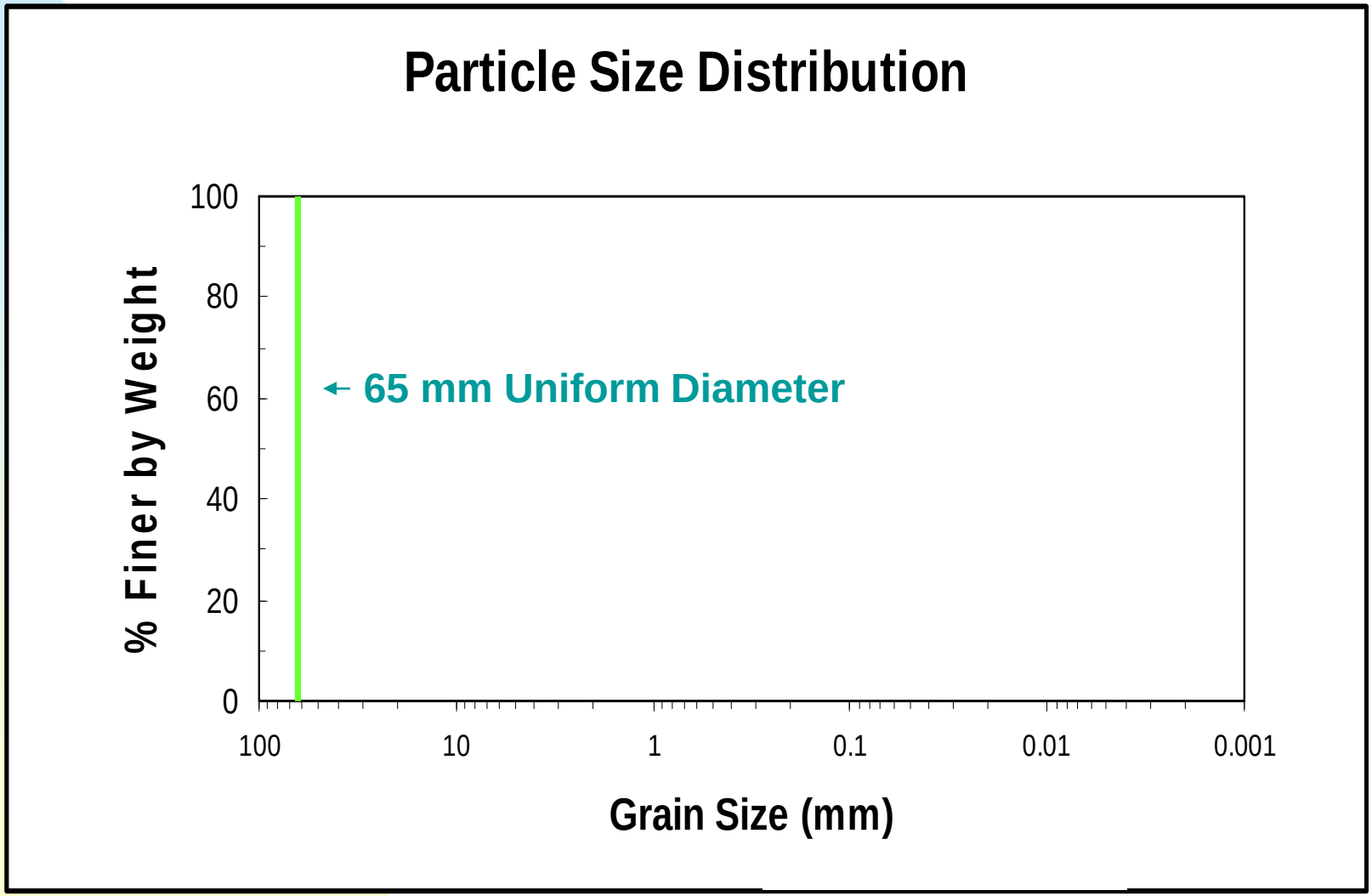
Geosynthetic Functions

- **Separation:**
  - Preventing the intermixing (contamination) between two dissimilar materials.
- **Filtration:**
  - Allowing the free flow of water while holding back erodible fines.
- **Reinforcement:**
  - Mechanically improving the engineering properties of soils and aggregates.

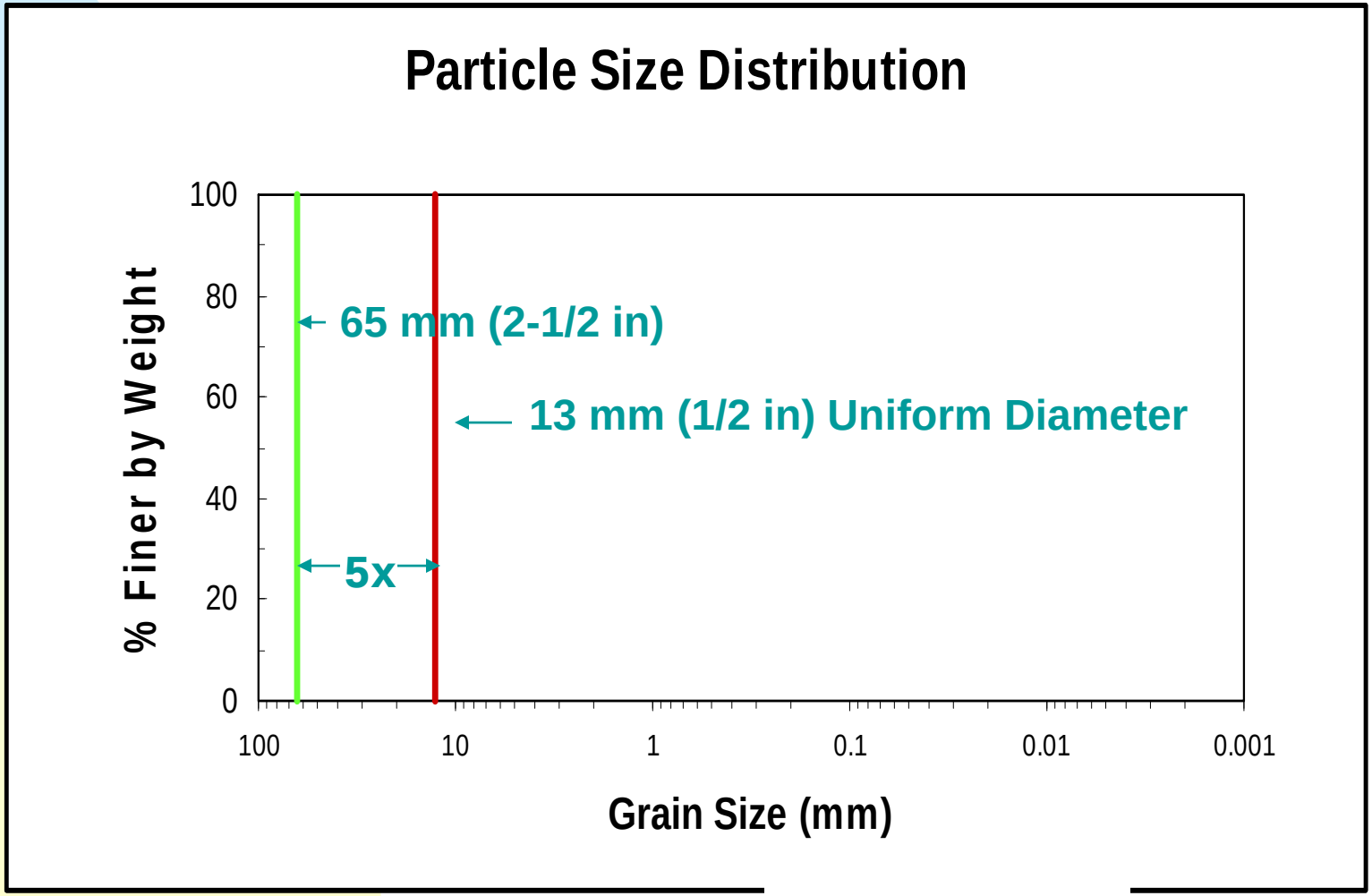
Immobilization at Interface is Key!



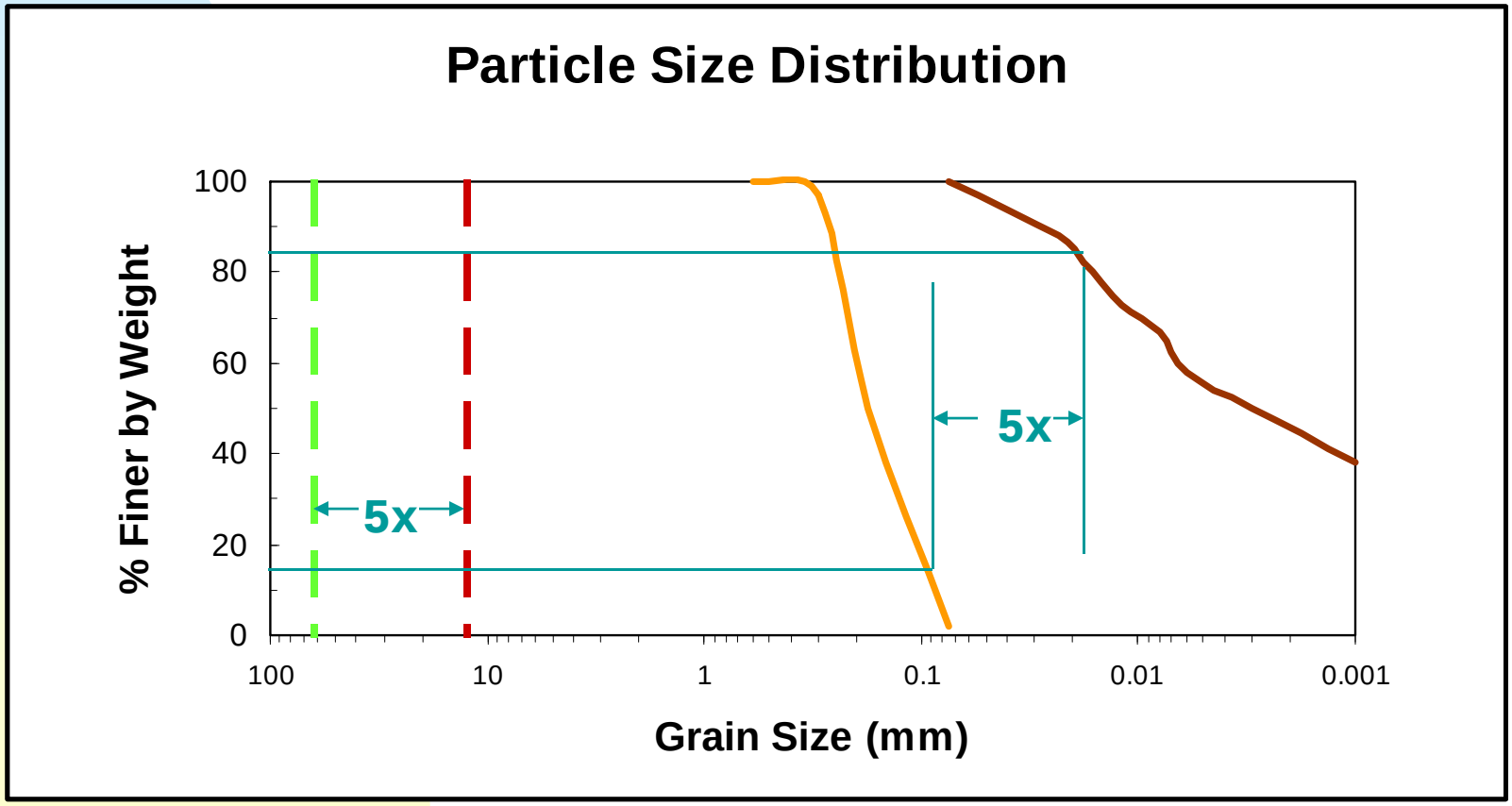
A Sieve Analysis of Tennis Balls…



… and also Marbles



Subgrade Particles Cannot Infiltrate Aggregate Fill Just as Marbles Cannot Infiltrate Tennis Balls.



Filter Criteria

- For Clayey Subgrades:

$$\text{Piping Ratio} = \frac{D_{15f}}{D_{85s}} < 5$$

- For Silty Subgrades:

$$\text{Piping Ratio} = \frac{D_{15f}}{D_{85s}} < 5$$

$$\text{Average Size Ratio} = \frac{D_{50f}}{D_{50s}} < 25$$

Geogrid alone w/ Agg

See “Geogrid Separation” paper.

So if Water is Present and Filter Criteria are Not Satisfied…

- (1) Consider an Alternative (i.e. Sandier) Aggregate Fill, at Least for the First Lift.
- (2) Consider a Nonwoven Geotextile Beneath the Geogrid, but Only if the Subgrade is Not Silty.

Economics

Say Agg Base (Installed) = $15 / ton = $0.75 per sy-in

and Say Undercut = $3.60 / cy = $0.10 per sy-in

Geotextile (Installed) ~ $1.70 per sy

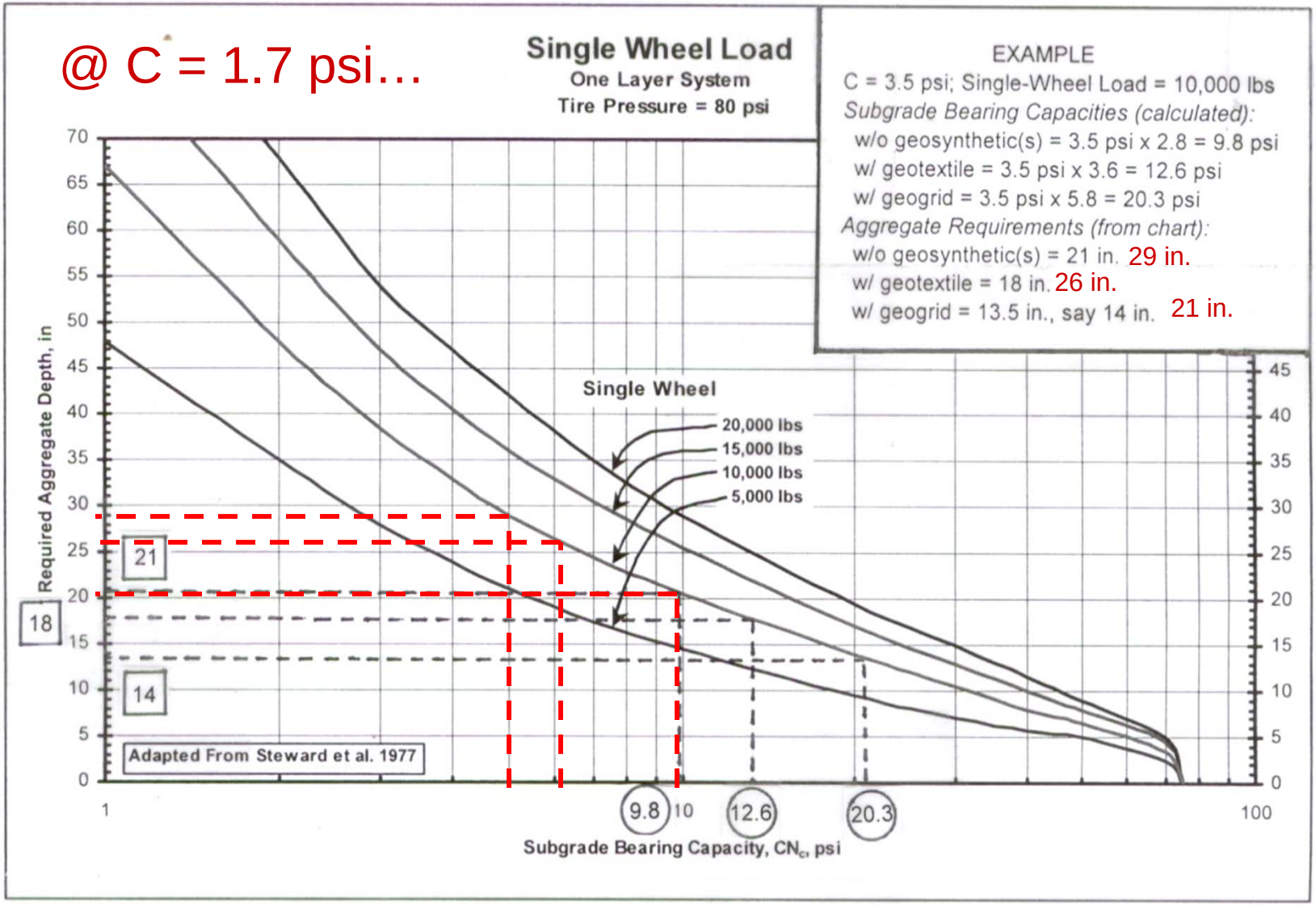
Geogrid (Installed) ~ $5.50 per sy

“Break-Even” Thicknesses:

Geotextile: $1.70 / ($0.75 + $0.10) = 2 inches

Geogrid: $5.50 / ($0.75 + $0.10) = 6-1/2 inches

@ C = 1.7 psi…



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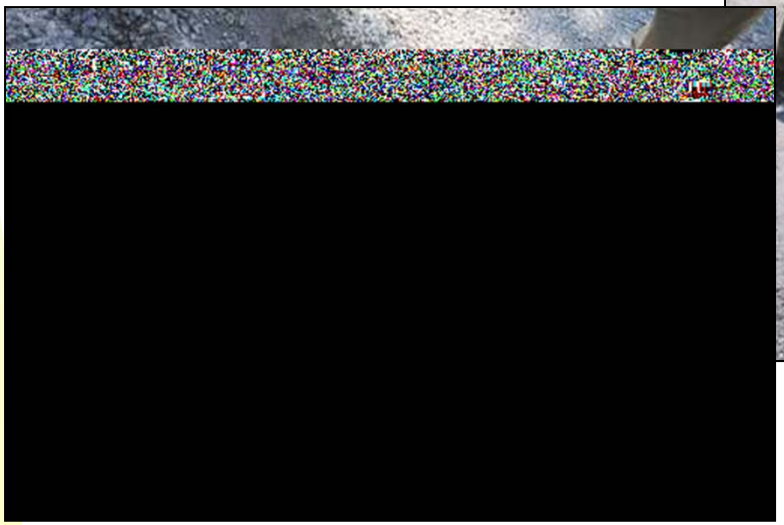
Call to Action

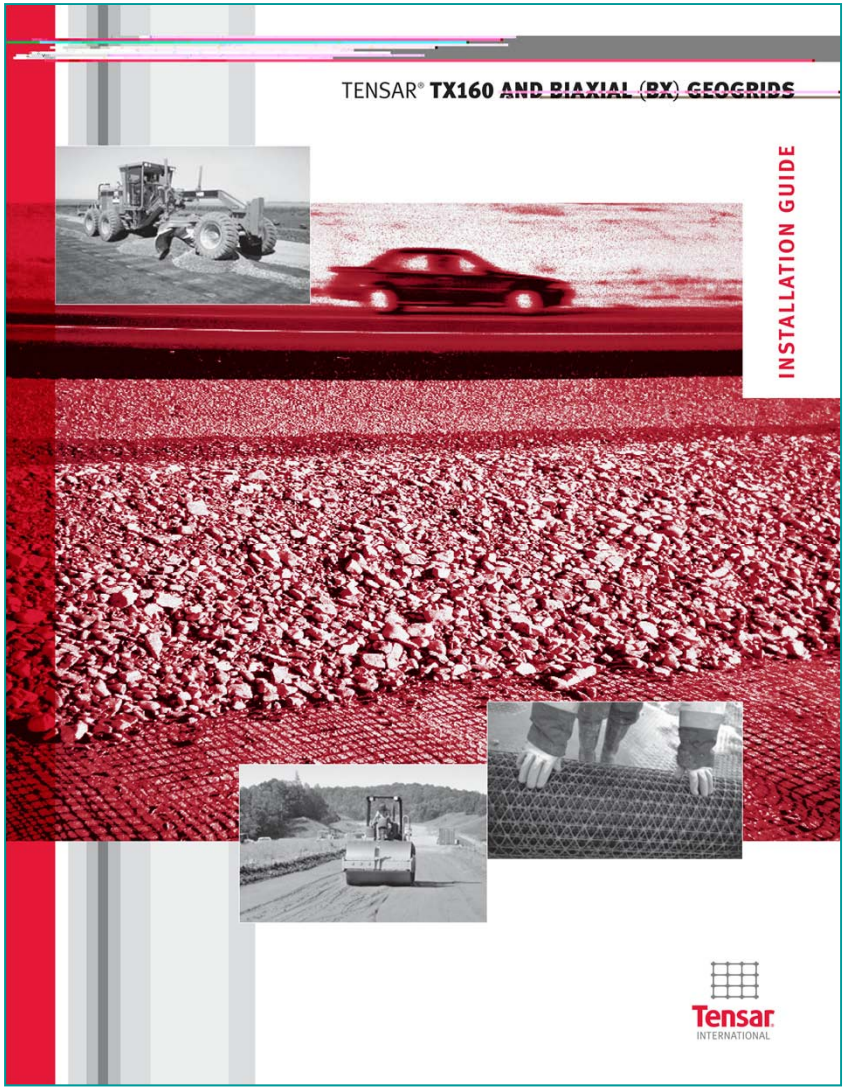
- Quantify Subgrade Strength.
- Consider Loading & Serviceability.
- Apply Credible Thickness Criteria.
- Check Separation/Filtration.
- Call for Pricing; Site Service.



Questions?

Proper Installation is Critical

- Guide Addresses:
  - Getting Started
  - Site Preparation
  - Placing / Overlapping
  - Tensioning Geogrid
  - Placing Aggregate Fill
  - Compacting Fill
  - Special Considerations
  - Estimating Tools



Summary of Installation Parameters

- Parameters are a function of subgrade strength.

Image 3 Rolling out Tensar Geogrid.

2. Site Preparation

- Clear, grub and excavate (if necessary) to the design subgrade elevation, stripping topsoil, deleterious debris and unsuitable material from the site. For very soft soils (CBR < 0.5), it may be beneficial to minimize
- Place the rolls of Tensar Geogrid* in position, cut the roll bands and manually unroll the material over the prepared surface (Image 3). In unpaved subgrade improvement applications, this surface will always

Summary of Tensar® Geogrid Installation Parameters

Subgrade Strength	Clear All Vegetation?	Geogrid Orientation[3]	BX Overlap[4]	Nylon Zip Ties?[1, 2]	Direct Traffic?[5]	Geotextile?[6]
CBR ≤ 0.5	N	T or L	3 ft	Y	N	Analysis Req'd
0.5 ≤ CBR ≤ 2	Usually	L	2–3 ft	N	N	Analysis Req'd
2 ≤ CBR ≤ 4	Y	L	1–2 ft	N	Limited	Analysis Req'd
4 ≤ CBR	Y	L	1 ft	N	Y	N

Notes:
1. Summary is a generalized presentation; see text for specifics.
2. Y = Yes, normally required; N = No, normally not required.
3. Geogrid Orientation (roll axis in relation to traffic): T = Transverse, L = Longitudinal.
4. General Geogrid Overlap Rule: Overlap = 3 ft for CBR ≤ 1; Overlap = 1 ft for CBR ≥ 4; interpolate between.
5. Direct Traffic pertains only to conventional rubber-tired equipment.
6. Analysis Required = Geotextile required only if filtration criteria is not met by aggregate fill.