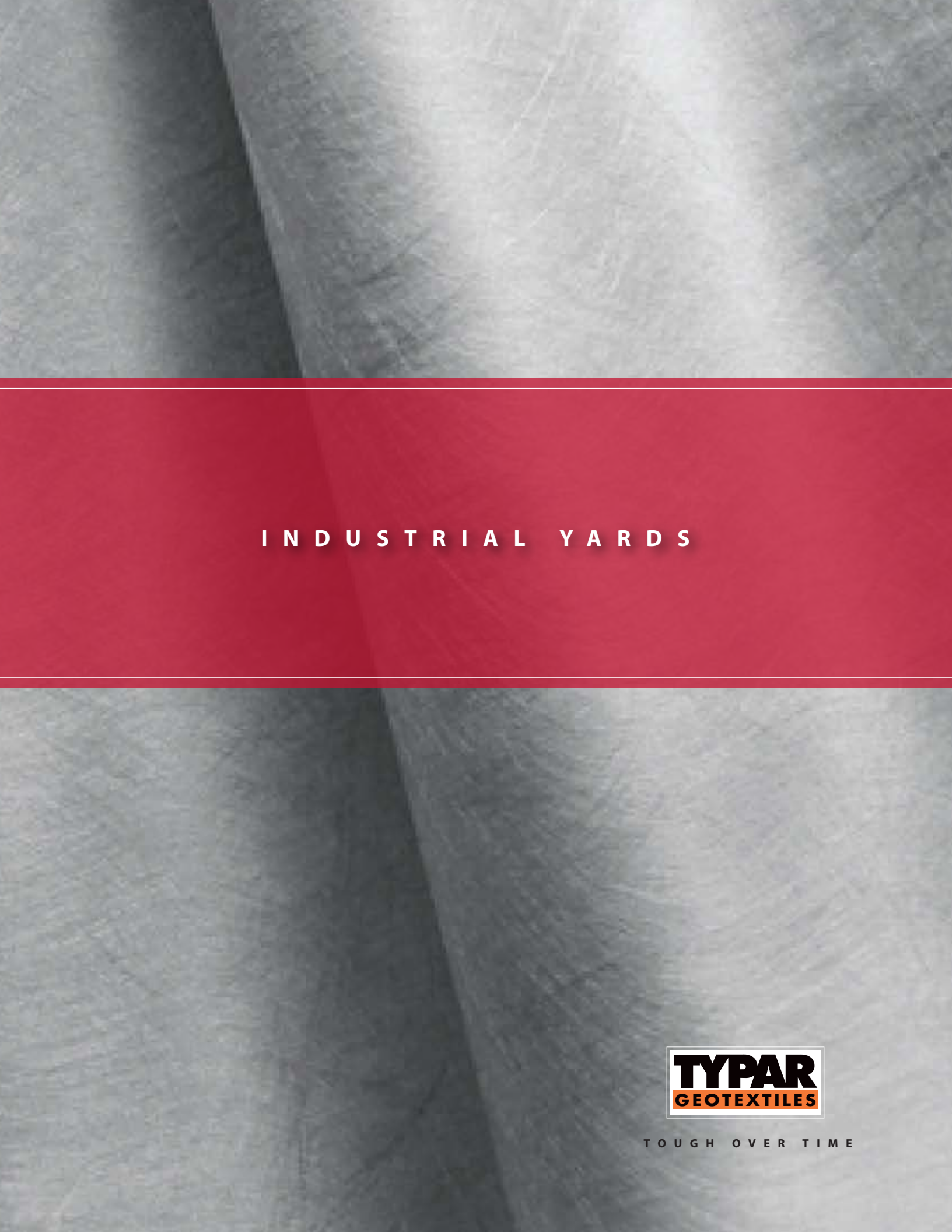

INDUSTRIAL YARDS

TYPAR GEOTEXTILES

TOUGH OVER TIME

INDUSTRIAL YARDS

TYPAR GEOTEXTILES

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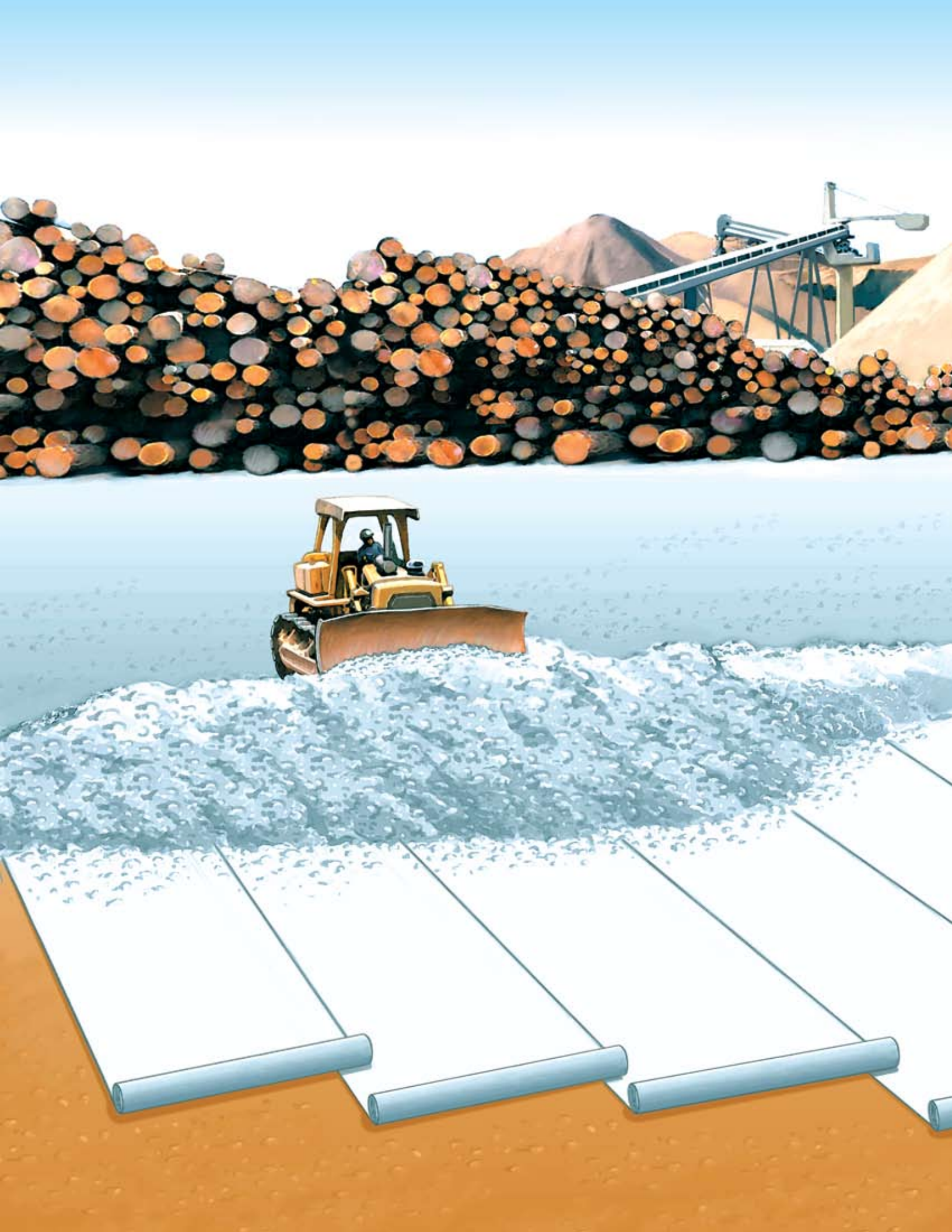


1.0 FEATURES OF INDUSTRIAL YARDS

Industrial yards are work areas built without an asphalt or concrete surface, so they derive all structural support from their aggregate base layers. Industrial yards are used for many purposes including:

- Construction pads for heavy equipment
- Fabrication yards
- Dock areas
- Railroad freight yards
- Truck freight yards
- Log storage areas
- Ore storage areas

Industrial yards and work areas are constructed of a layer of aggregate base placed directly on the subgrade soil; a thin asphalt surface layer is sometimes placed on top of the aggregate. The aggregate layer, not the asphalt, provides structural support for the firm, flat surface that large, heavy equipment requires for operation. Without it, efficiency is reduced and required maintenance is increased.

Industrial yard surfaces constructed over good subgrades can be problematic enough, but when they are constructed over weak subgrades maintenance can become a real problem. Even with very thick layers of aggregate, heavy trucks and equipment using the yard (especially when it is wet) cause intermixing of the aggregate base and subgrade soil; this deforms the yard surface and causes ruts. As the yard progressively deteriorates, it's either regraded with new aggregate or becomes unusable.

2.0 HOW TYPAR GEOTEXTILES WORK

The progressive downward movement of aggregate into the subgrade and the associated upward squeezing or pumping of subgrade soil into the aggregate base results in intermixing (Figure 1). This intermixing reduces load-bearing base thickness, therefore reducing the strength and load-bearing capacity, which results in the failure of the yard.

Typar geotextiles separate, stabilize and strengthen industrial yards by providing a permeable separation

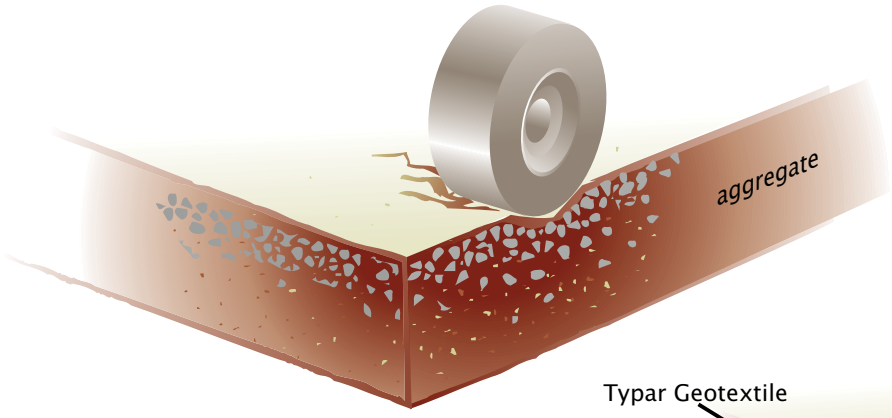


Figure 1 (Left): Without Typar, soil contaminates and weakens aggregate base, resulting in failure of the yard.

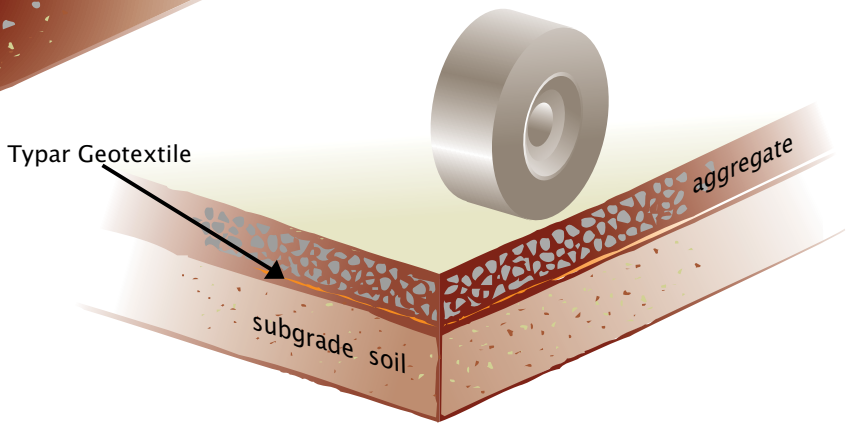


Figure 2 (Right): With Typar, aggregate won't sink into the soil and intermix with the subsoil.

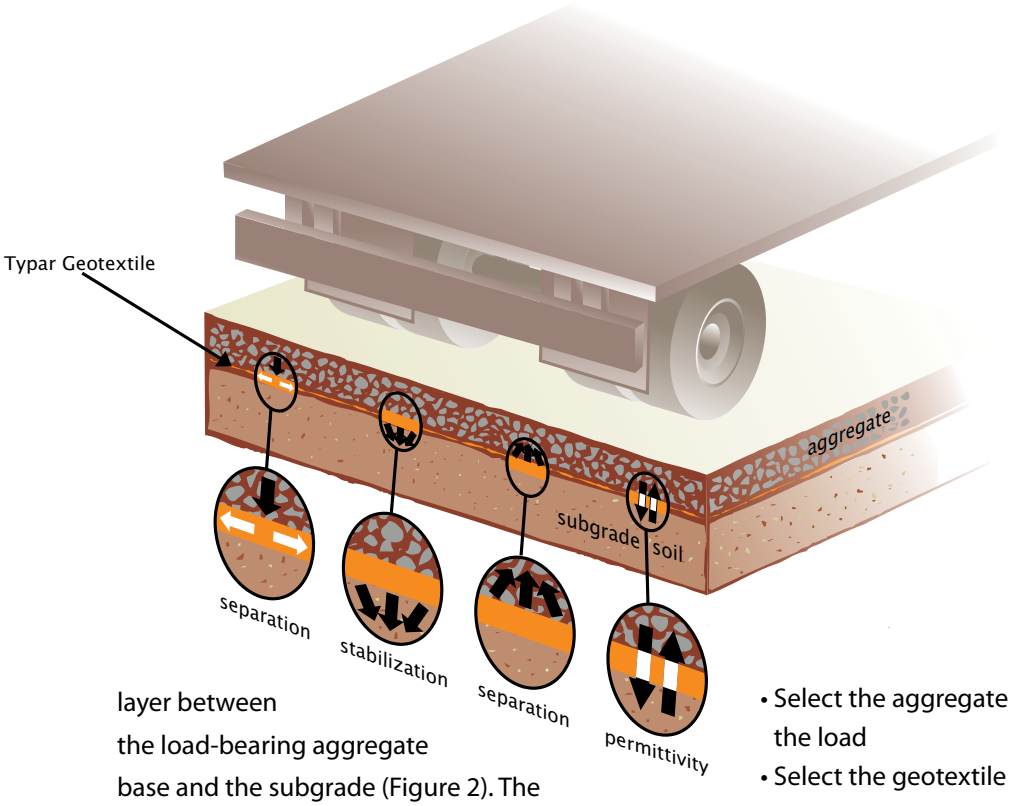


Figure 3: Typar stabilizes and strengthens industrial yards by providing a separation layer between the aggregate base and subgrade.

layer between the load-bearing aggregate base and the subgrade (Figure 2). The geotextile separator minimizes intermixing and helps maintain the integrity and load-bearing ability of the aggregate base, preserving the original design and life expectancy of the yard.

When Typar geotextiles are included in the design, between the aggregate base and subgrade soil, intermixing is minimized and any allowance of aggregate base for intermixing can then be reduced.

3.0 DESIGN CONSIDERATIONS AND SELECTION OF GEOTEXTILES

The depth of aggregate and class of geotextile required are dependent upon a number of factors. The following procedure is recommended to select a Typar geotextile:

- Determine traffic volume
- Determine soil subgrade strength
- Determine the required aggregate thickness
- Calculate aggregate thickness adjustment for wheel loading
- Select the aggregate and adjust the thickness for the load
- Select the geotextile

3.1 DETERMINE TRAFFIC VOLUME

Two categories of yards are normally identified –temporary and permanent. Temporary is considered less than 1,000 passes over the design life of the yard. Permanent is considered greater than 1,000 passes. Determine the category that has been chosen.

As an example, we will use a permanent installation.

3.2 DETERMINE SOIL SUBGRADE STRENGTH

Determine the subgrade soil strength using the field California Bearing Ratio (CBR), cone penetrometer, vane shear, resilient modulus or other appropriate test (ASTM D1883). Take soil samples from the areas that appear weakest. Tests should be performed when the soil is at its weakest–wet or saturated. If necessary, estimate the soil CBR using the rule of thumb in Figure 4.

For our example, the CBR test will result in a CBR of 2.0.

APPROXIMATE CBR	IDENTIFICATION PROCEDURE
Less than 2	Easily penetrated with thumb
2 - 3	Moderate effort to penetrate with thumb
3 - 6	Indented by thumb
6 -16	Indented by thumbnail
Over 16	Difficult to indent with thumbnail
Note: This CBR testing method is a non-scientific approximation of soil strength in unsoaked conditions.	

Figure 4: Simple CBR identification procedure.

3.3 DETERMINE THE REQUIRED AGGREGATE THICKNESS

In determining aggregate thickness, an allowable rut depth of 3 inches is recommended. Use Figure 5 for temporary installations (< 1,000 passes) and Figure 6 for permanent installations (> 1,000 passes) to determine the depth of aggregate needed. The resultant thickness is based on maximum axle load of 18,000 lbs.

For our example, from the chart for permanent installations and a CBR test of 2.0, the approximate aggregate depth recommended is 13 inches.

3.4 CALCULATE AGGREGATE THICKNESS ADJUSTMENT FOR WHEEL LOADING

The aggregate thickness obtained from Figure 5 or Figure 6 is based on a maximum axle load of 18,000 lbs. If axle loads other than 18,000 lbs are frequently encountered, a thickness adjustment for various axle loads can be obtained from Figure 7. The thickness adjustment should be added to or subtracted from the value obtained from Figure 5 or 6.

The following maximum axle load values are a guide to the class of vehicle that might be making use of the yard:

Light duty (i.e. cars and light trucks, 3,000 lbs)
Medium duty (i.e. typical truck loads, 18,000 lbs)
Heavy duty (i.e. earth moving equipment, 25,000 lbs +)

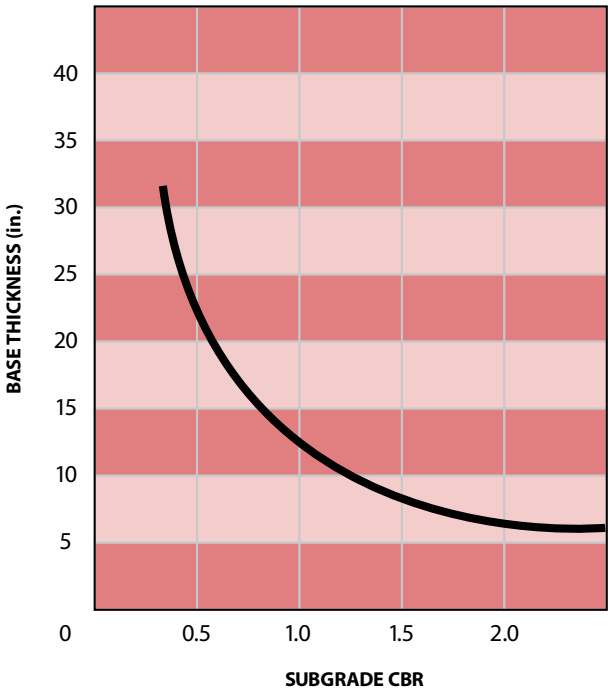


Figure 5: Less than 1000 vehicle passes, 3" allowable rut depth.

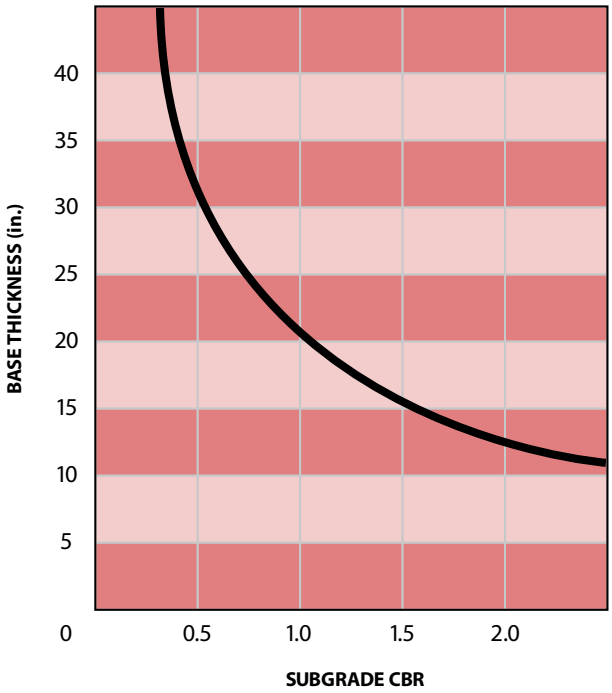


Figure 6: More than 1000 vehicle passes, 3" allowable rut depth.

Continuing our example, the heavy-duty earth moving equipment using the yard will require an increase in the aggregate indicated in Figure 7.

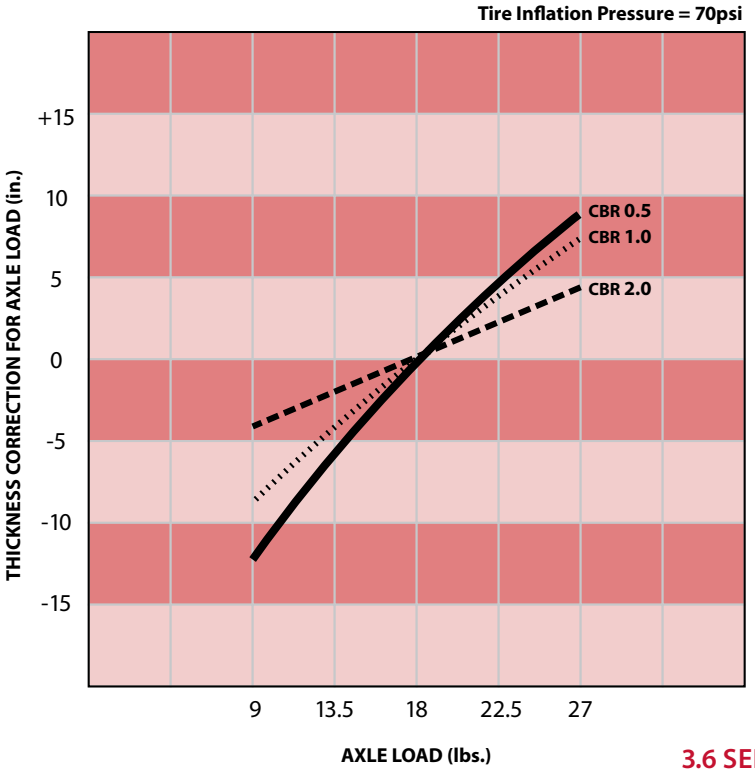


Figure 7: Aggregate thickness adjustment for various axle loads.

Since the axle load is 25,000 pounds, Figure 7 indicates approximately 4 inches of aggregate should be added to the 13 inches resulting in a total 17 inches of aggregate.

AGGREGATE MATERIAL	TYPICAL EFFICIENCY
Hard rock (will scratch with a knife)	100%
Medium rock (will scratch with a coin)	80%
Shell	70%
Ripable hardpan	54%
Soft rock (will scratch with a fingernail)	44%
Loose gravel and sandy gravel	38%
Compactible sand	38%

Figure 8: Efficiency factor of various industrial yard base materials.

3.5 SELECT THE AGGREGATE AND ADJUST THE THICKNESS FOR THE LOAD

Selection of the aggregate base material is based on cost or availability. Angular crushed stone is standard base aggregate material. When other materials or blends are used, the efficiency varies and adjustments need to be made to the calculated aggregate thickness. The efficiency factors of various industrial yard base materials are tabulated in Figure 8. For our example, if we choose ripable hardpan, it is 54 percent as effective as crushed stone so the thickness needs to be increased by dividing the axle load adjusted aggregate value by 0.54, which gives us a final total aggregate thickness of approximately 31 inches.

3.6 SELECT THE GEOTEXTILE

The maximum stress experienced by the geotextile is normally during installation. Once aggregate has been placed, the geotextile is "insulated" by the layer of aggregate and can be relied on to remain in position and perform the separation and stabilization function throughout the life of the industrial yard.

AASHTO M288 is the applicable specification for the use of geotextiles as a separator to prevent mixing of a subgrade soil and an aggregate cover material based on survivability from installation stress. Selection of the appropriate AASHTO Geotextile Class and Typar style is dependent on the harshness of the subgrade surface, strength of the subgrade soil and whether the soil is saturated or unsaturated during installation.

Use Figure 9 to select the appropriate AASHTO Class and Typar geotextile style.

Soil Strength	SOAKED CONDITIONS		
	Notes	AASHTO M288 Class	Typar Style
CBR less than 1	1	–	3631
CBR between 1 and 3	2	Class 1 or 2	3631 or 3501
CBR greater than 3	3	Class 2 or 3	3501 or 3401

Notes:
1. Reinforcement is required.
2. Typar 3501 is recommended unless installation conditions are particularly harsh.
3. Typar 3401 is recommended unless installation conditions are particularly harsh.

Figure 9: Selection of AASHTO M288 Class and Typar style based on soil conditions at the time of installation.

GUIDE TO GROUND (TIRE) PRESSURE			
Subgrade Conditions	**Low ground pressure equipment** (i.e. cars and light trucks) ≤ 25 kPa ≤ 4 psi	**Medium ground pressure equipment** (i.e. typical trucks) > 25 kPa ≤ 50 kPa > 4 psi ≤ 8 psi	**High ground pressure equipment** (i.e. earth moving equip.) > 50 kPa > 8 psi
Subgrade has been cleared of all obstacles except grass, weeds, leaves and fine wood debris. Surface is smooth and level so that any shallow depressions and humps do not exceed 18 inches in depth or height. All larger depressions are filled. Alternatively a smooth working table may be placed.	Low N/A Typar 3341	Moderate Class 3 Typar 3401	High Class 2 Typar 3501
Subgrade has been cleared of all obstacles larger than small to moderate size tree limbs and rocks. Tree trunks and stumps should be removed or covered with a partial working table. Depressions and humps should not exceed 18 inches in depth or height. Larger depressions should be filled.	Moderate Class 3 Typar 3401	High Class 2 Typar 3501	Very High Class 1 Typar 3631
Minimal site preparation is intended. Trees may be felled, delimbed, and left in place. Stumps should be cut to project not more than 6 inches above subgrade. Fabric may be draped directly over the tree trunks, stumps, large depressions and humps, holes, stream channels and large boulders. Items should be removed only if placing the fabric cover material over them will distort the finished road surface.	High Class 2 Typar 3501	Very High Class 1 Typar 3631	Not recommended N/A N/A

Recommendations are for 6-12 inch initial lift thickness. For other lift thicknesses:

12-18 inch – Reduce survivability requirement one level | 18-24 inch – Reduce survivability requirement two levels
> 24 inch – Reduce survivability requirements three levels

For special construction conditions like pre-rutting, increase fabric survivability requirement one class. Placement of excessive initial thickness may cause bearing failure of the soft subgrade.

Figure 10: Recommended Typar styles depending upon site conditions and construction procedure.

4.0 INSTALLATION GUIDE

Successful use of geotextiles in yard design requires proper installation. Follow the sequence of installation in the diagrams in Figure 11.

Prepare the installation site by clearing, grubbing, and excavating or filling the area to the design grade. Soft spots and unsuitable areas identified during site preparation or subsequent proof rolling should be excavated and backfilled with select material and then compacted using normal procedures.

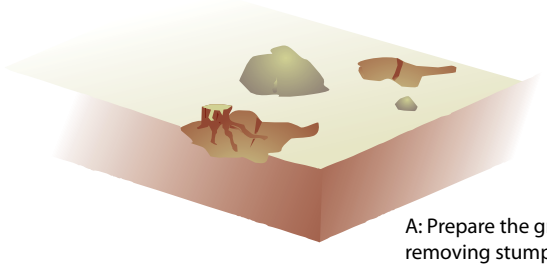
The geotextile should be laid smooth without wrinkles or folds on the prepared subgrade in the direction of construction traffic.

Prior to covering, the geotextile should be inspected to ensure it has not been damaged (i.e. holes, rips, tears). If damage has occurred, the area should be covered with a geotextile patch that extends an amount equal to the required overlap beyond the damaged area.

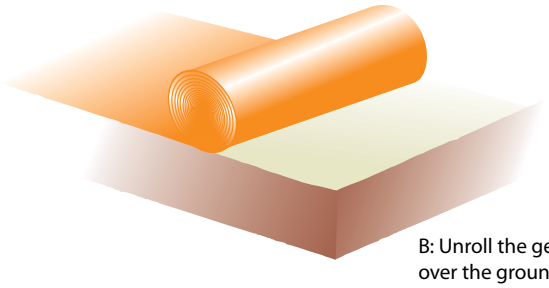
The base aggregate should be placed by end-dumping over previously placed aggregate and blading it forward on the geotextile.

Construction vehicles should not be allowed directly on the geotextile nor should vehicles turn on the first lift above the geotextile. Any low points during construction should be filled with additional base material and compacted. Do not blade aggregate to a low area from an adjacent area, but add new fill.

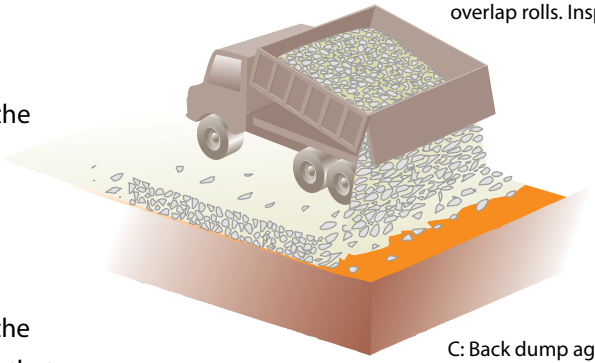
Once the geotextile is rolled out onto the surface, it needs to be covered with aggregate within 10 days to prevent degradation from ultraviolet light exposure.



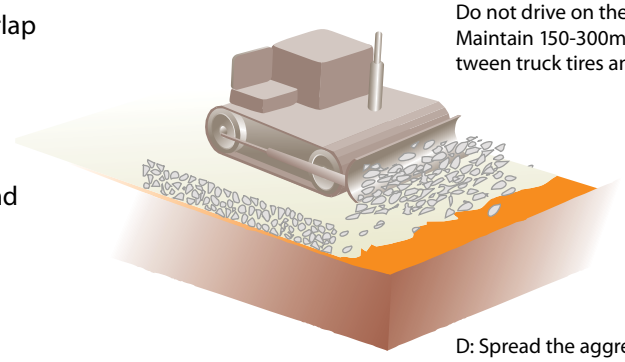
A: Prepare the ground by removing stumps, boulders, etc. Fill in low spots.



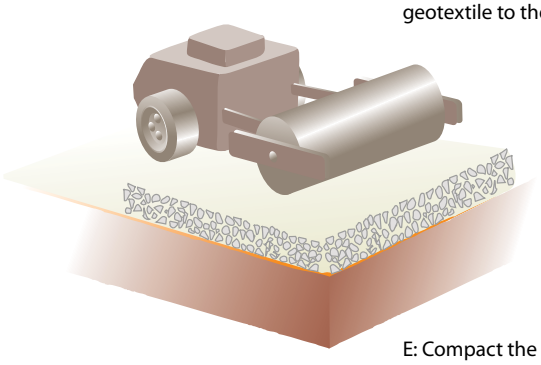
B: Unroll the geotextile directly over the ground to be stabilized. If more than one roll is required, overlap rolls. Inspect geotextiles.



C: Back dump aggregate onto previously placed aggregate. Do not drive on the geotextile. Maintain 150-300mm cover between truck tires and geotextile.



D: Spread the aggregate over the geotextile to the design thickness.



E: Compact the aggregate using dozer tracks or smooth drum vibratory roller.

Figure 11: Installation of Typar geotextiles.

5.0 OVERLAP AND JOINING

Overlaps provide continuity between adjacent geotextile rolls. Sufficient overlap is required to prevent fabric separation during base placement and compaction. The amount of overlap required is dependent on the shear strength (CBR) of the subgrade soil (Figure 12).

Pins or piles of stone may be used to maintain geotextile overlaps during installation. Geotextile roll widths should be selected so overlaps between rolls do not occur along anticipated primary wheel path locations. Overlaps at the end of rolls should be in the direction of the aggregate placement with the previous roll on top.

SOIL CBR	MINIMUM OVERLAP
Greater than 3	1 - 1 1/2 feet
1 - 3	2 - 3 feet
0.5 - 1	3 feet or sewn
Less than 0.5	Sewn
All roll ends	3 feet or sewn

Figure 12: Overlap guide.

6.0 SETTING SPECIFICATIONS

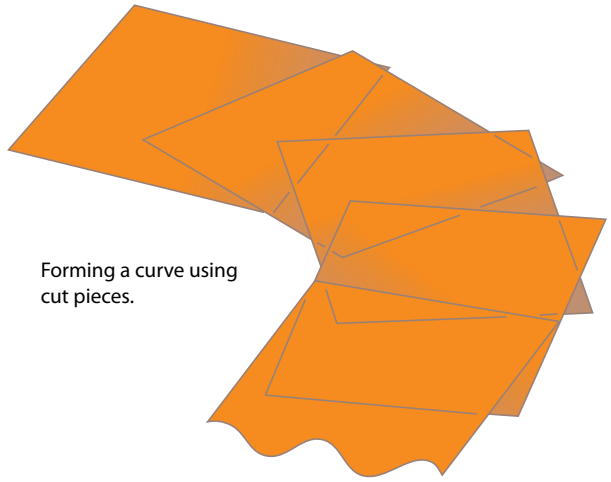
Specifications should generally follow the design considerations in sections 3.0 to 3.6. Primary considerations include the minimum geotextile requirements for the design and minimum requirements for survivability, retention and filtration.

For industrial yards, the engineer should specify an AASHTO M288 Stabilization Class of geotextile as follows:

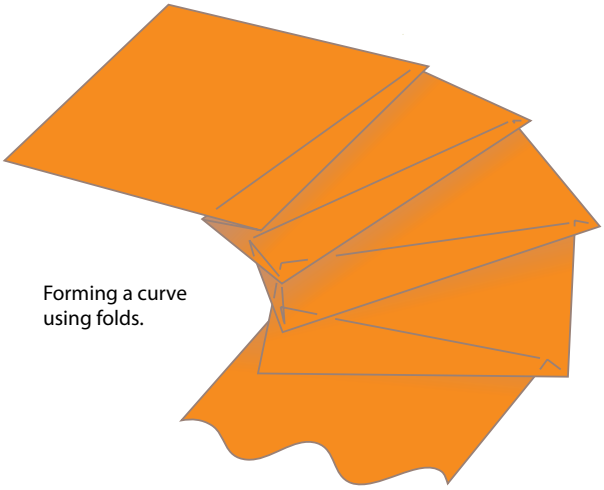
AASHTO M 288 Class 1 or TYPAR 3631,
AASHTO M 288 Class 2 or TYPAR 3501, or
AASHTO M 288 Class 3 or TYPAR 3401.

Additional requirements should reference the AASHTO M288; i.e. "for certification, sampling, testing and acceptance, shipment and storage requirements of AASHTO M288."

When specifying Typar geotextiles for construction pads, fabrication yards, freight yards and storage areas, specify the appropriate Typar grade with the confidence that all Typar geotextiles are manufactured to the high quality standards required by industrial yards.



Forming a curve using cut pieces.



Forming a curve using folds.