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Milling for Smoothness

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Overview

-Terminology

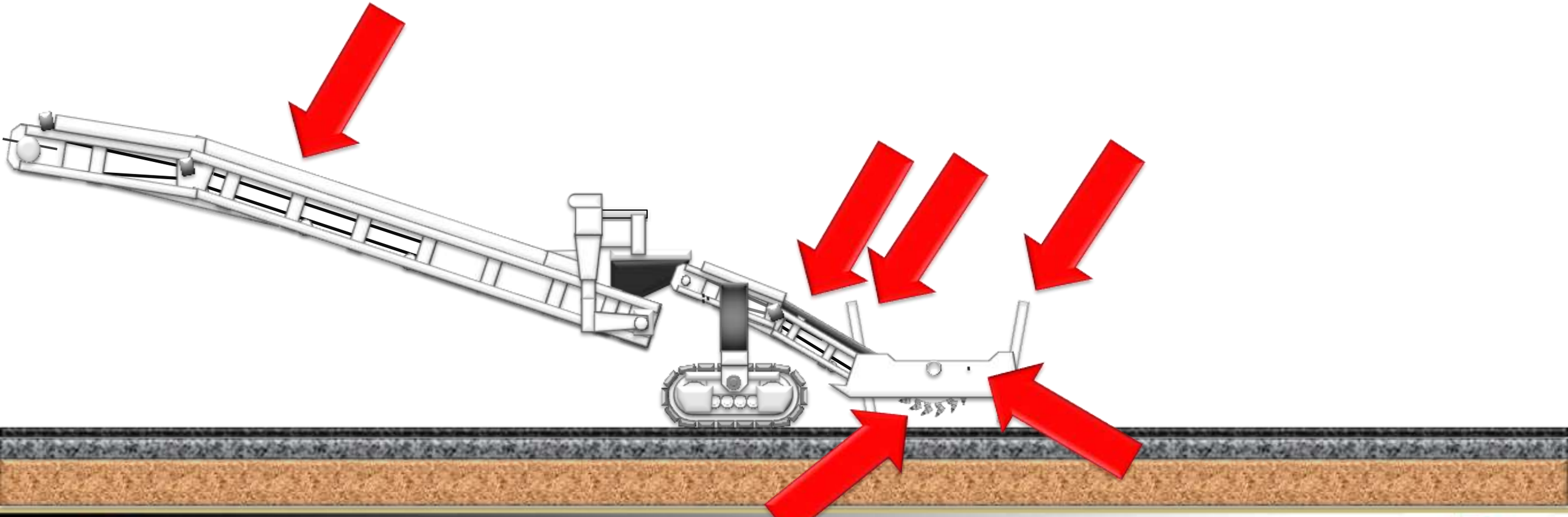
-How does this work?

-Why is this important?

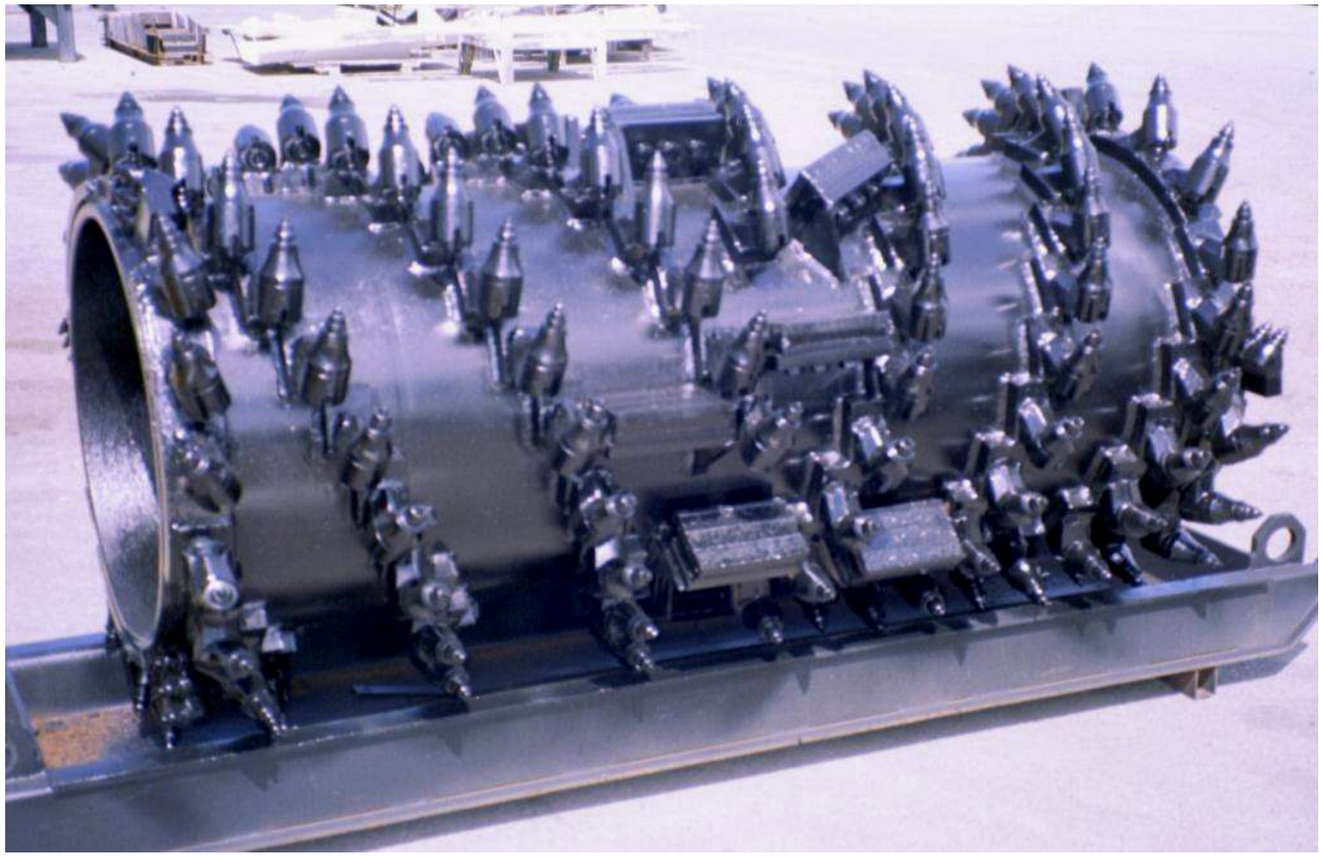
-Factors that affect the finished product

» Environment
» Machine Maintenance
» Machine Configuration
» Operating Practices

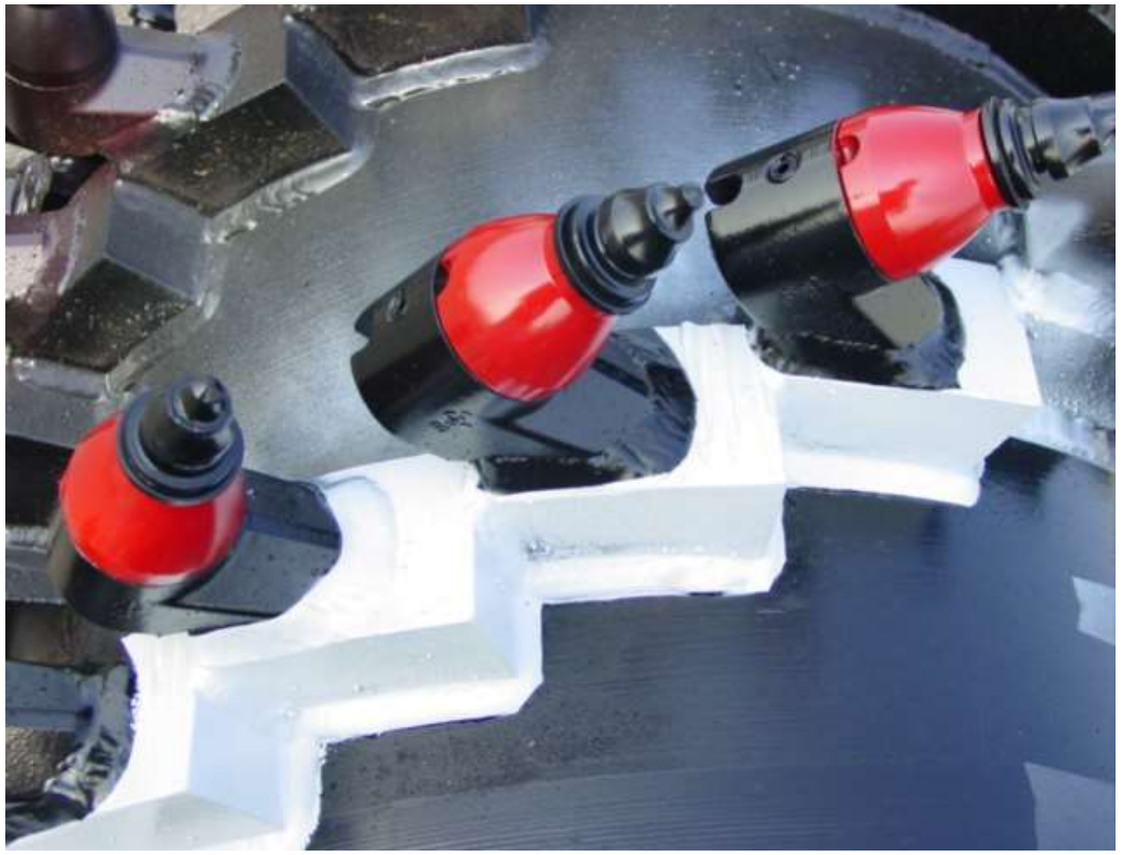
Terms of the machine



Terms of the machine- Cutter Drum



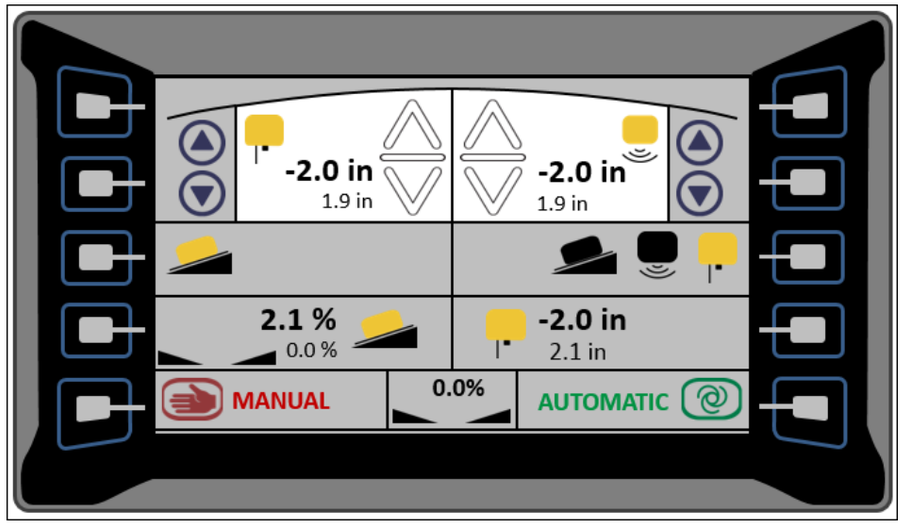
Standard Drum

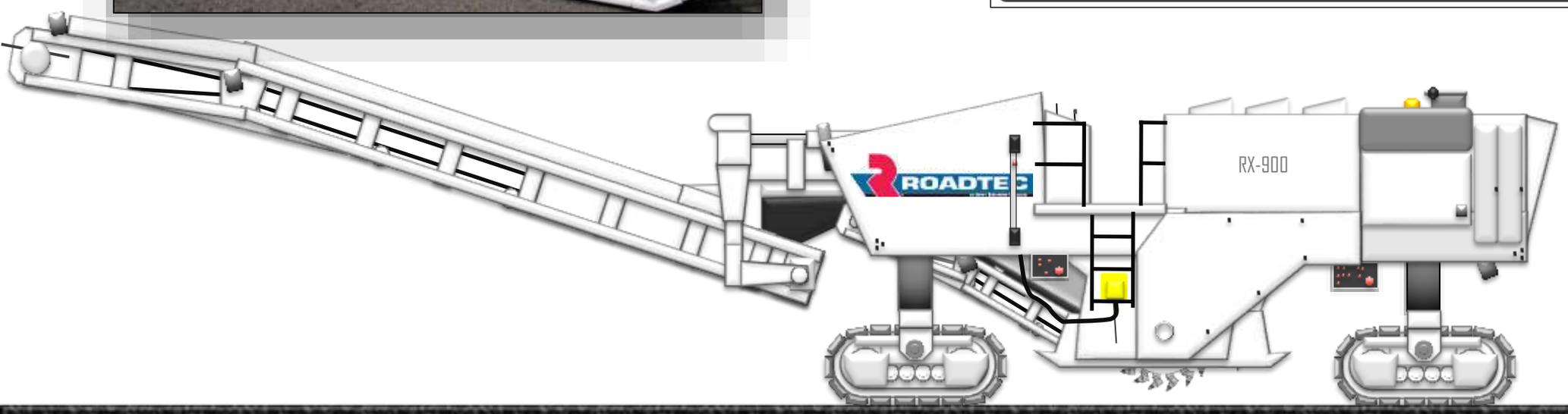


Triple Wrap

Offset Flighting

2D Control Systems

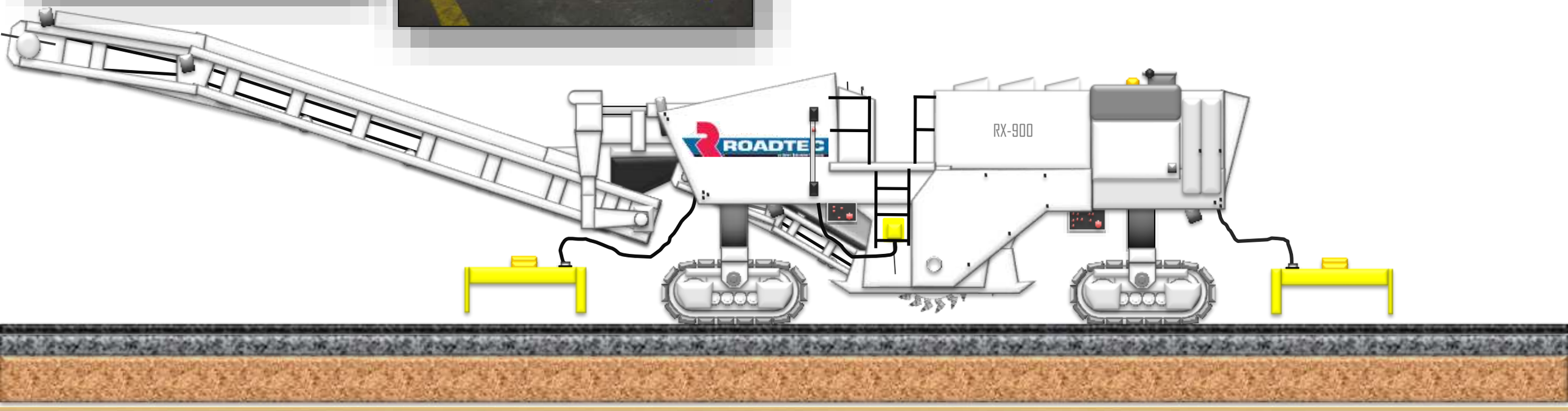




Averaging Systems

Do averaging systems work?

When should we use averaging?



3D Control Systems

Mill to Grade based on Position

They are only as accurate as the Data.

Why milling QC is important

The reference for paver grade/slope control is the milled surface

The paver won’t fix it

Ground man

Must to be in control of what is going on around the machine at all times.

A ground man needs to know what areas the machine will be referencing for grade, and make sure those surfaces are clean and free of obstructions

Control points

The job should be properly laid out

The beginning and end of each pass should be properly marked, as well as desired grade

Keep it Clean

Your Cut surface is only as good the surface you Walked on.

If you have this to work with you will never achieve grade.

Why?

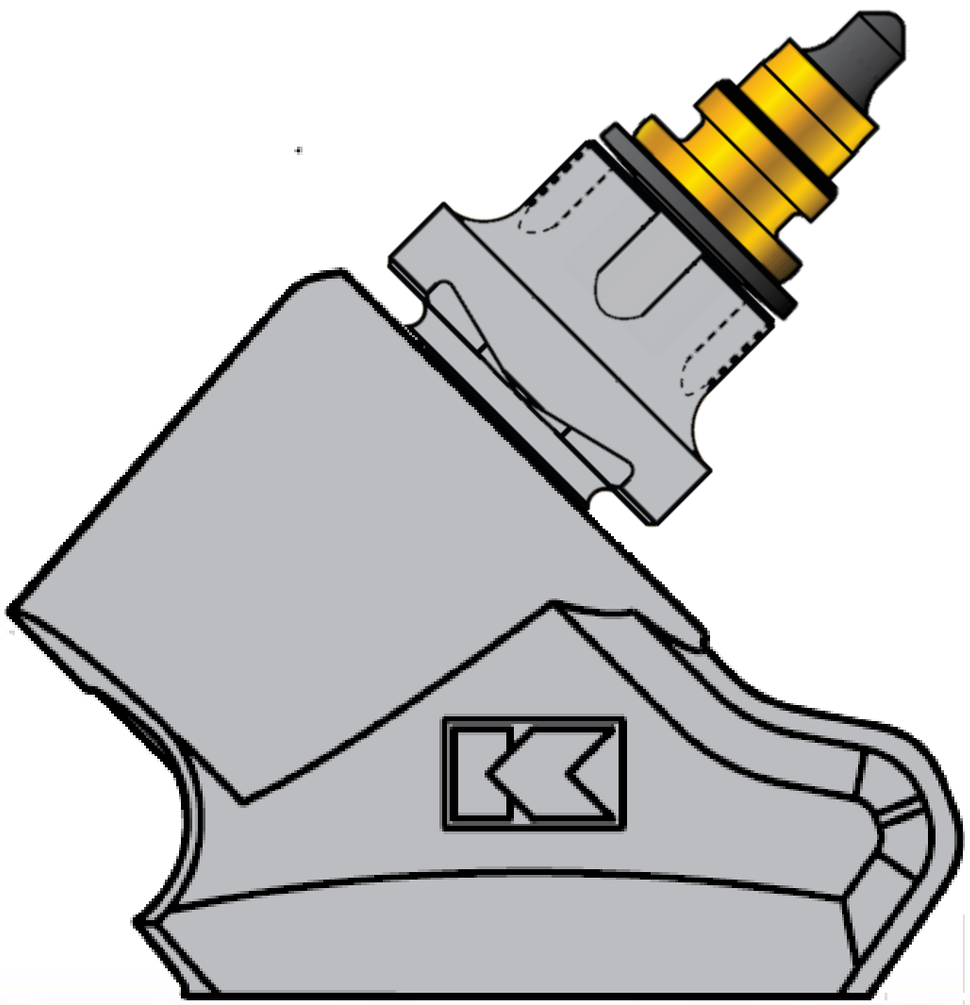
Clean up your mess

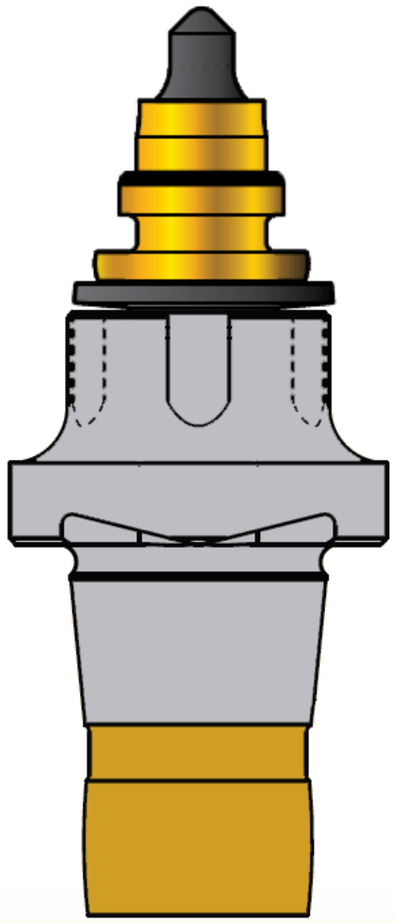
Clean up after you pick up.

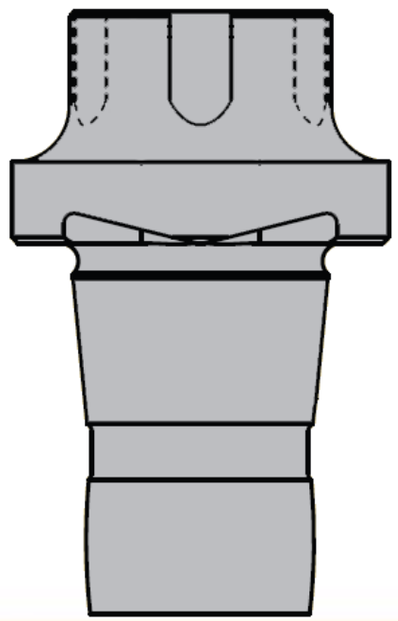
What will happen when you set back down.

Proper Tooling Maintenance

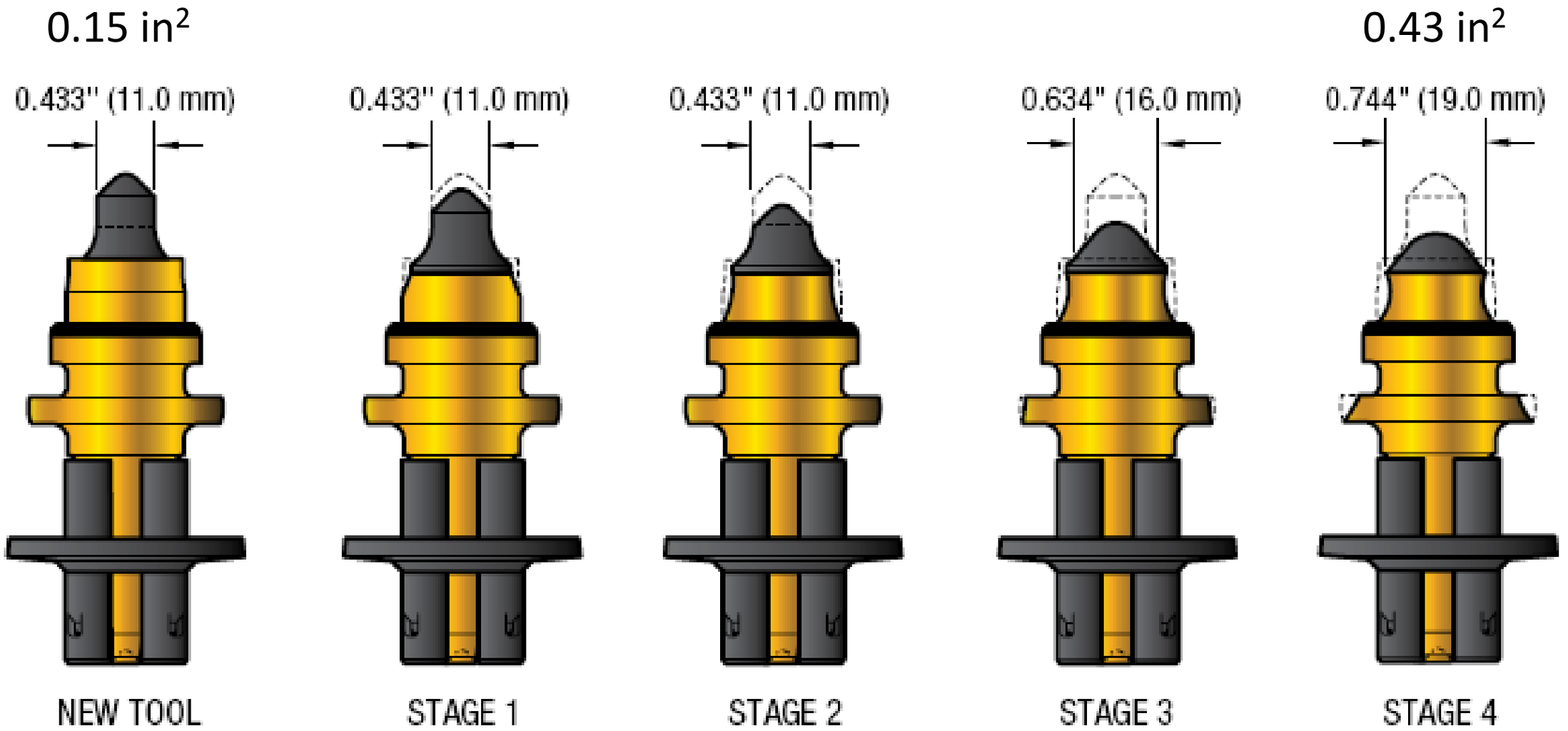
Proper Holder Wear





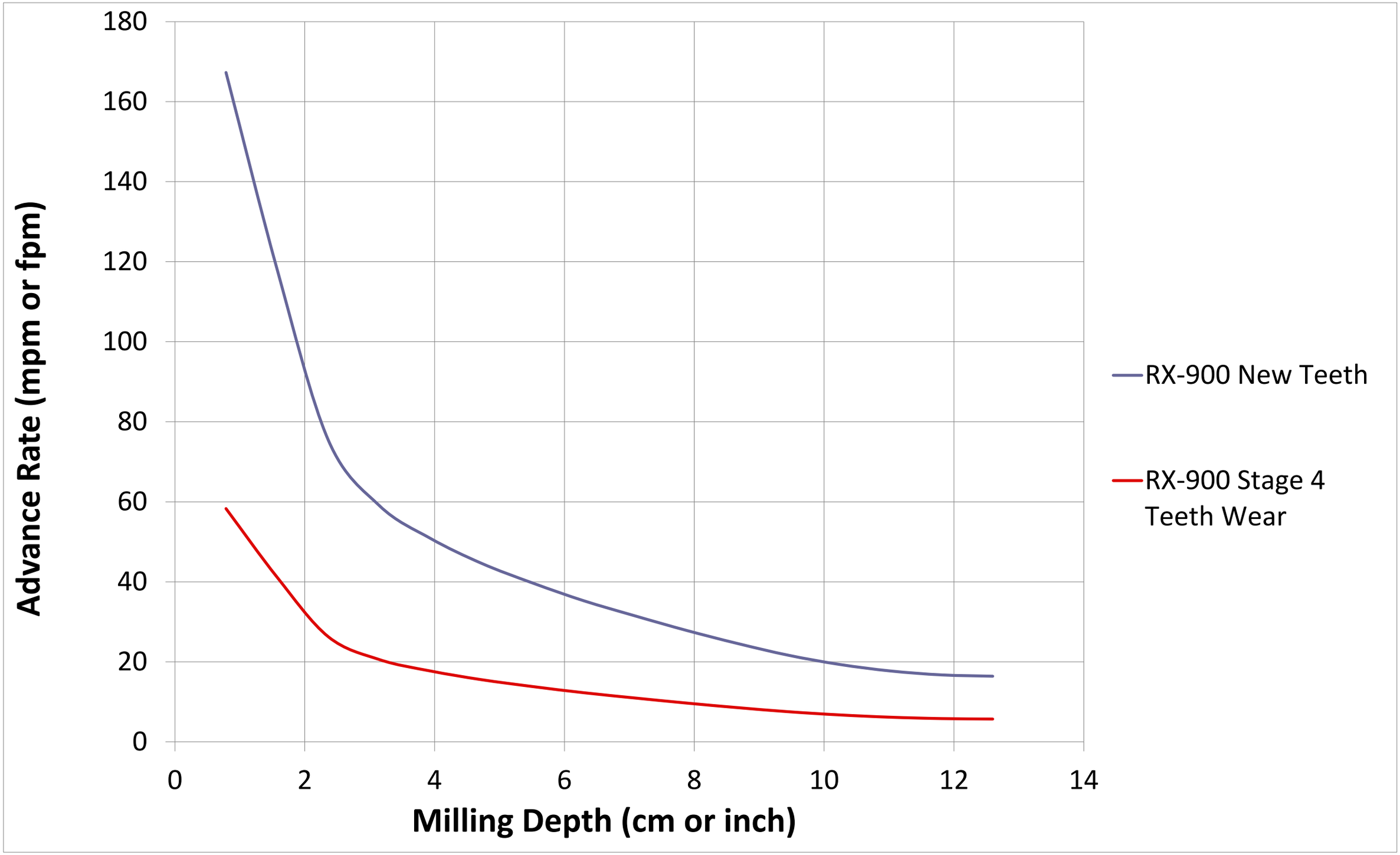


Tool Wear Characteristics



At Stage 3
Tool has lost 0.365 “ [9.3 mm] of gage height

Production Tradeoff

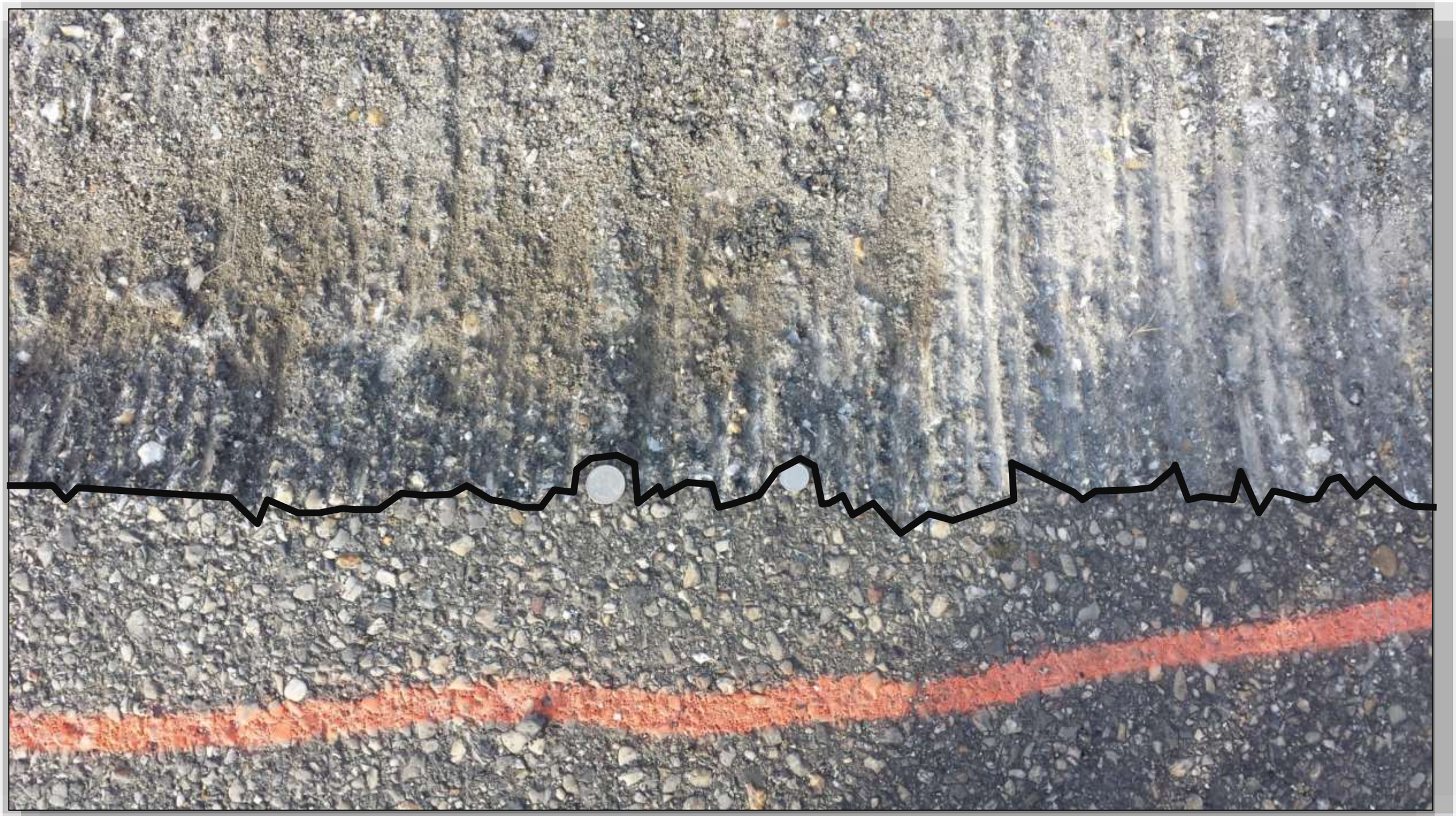


Look at the Holders

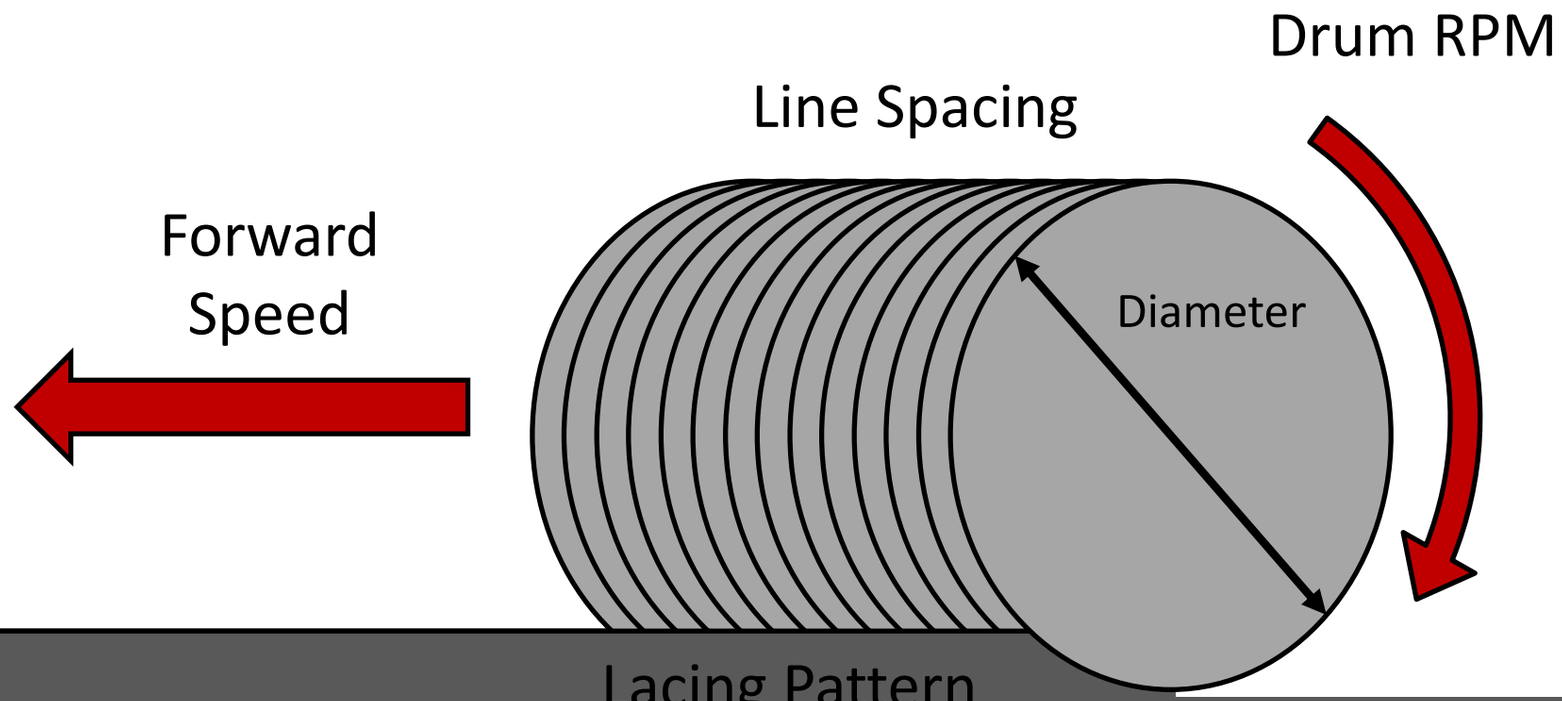
New holders change the drum pattern.

Caliper set at EXACTLY 2”

Proper Maintenance



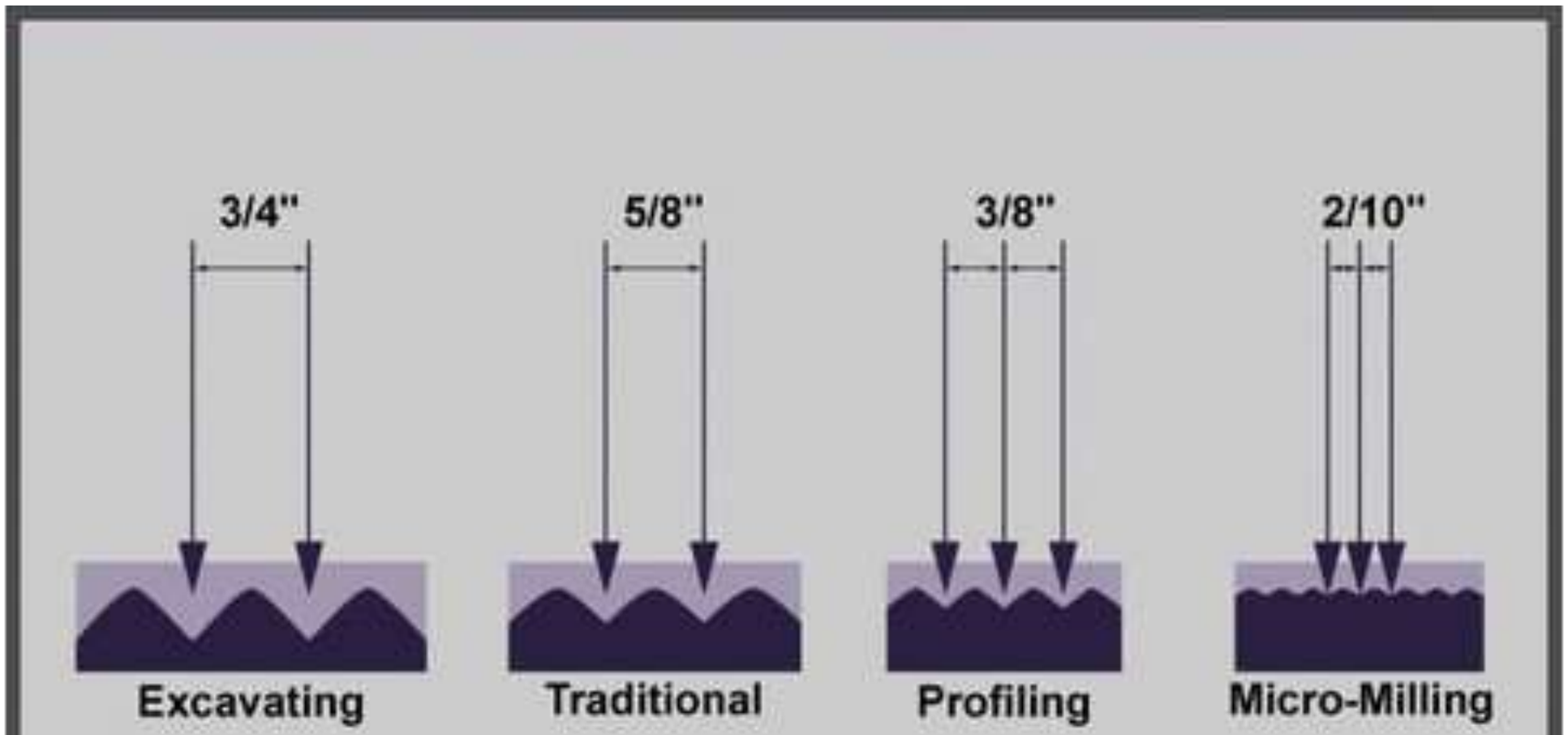
The Math of Milling



The 4 Main Factors that Affect Surface Texture

1. Line Spacing
2. Forward Speed
3. Drum RPM
4. Lacing Pattern

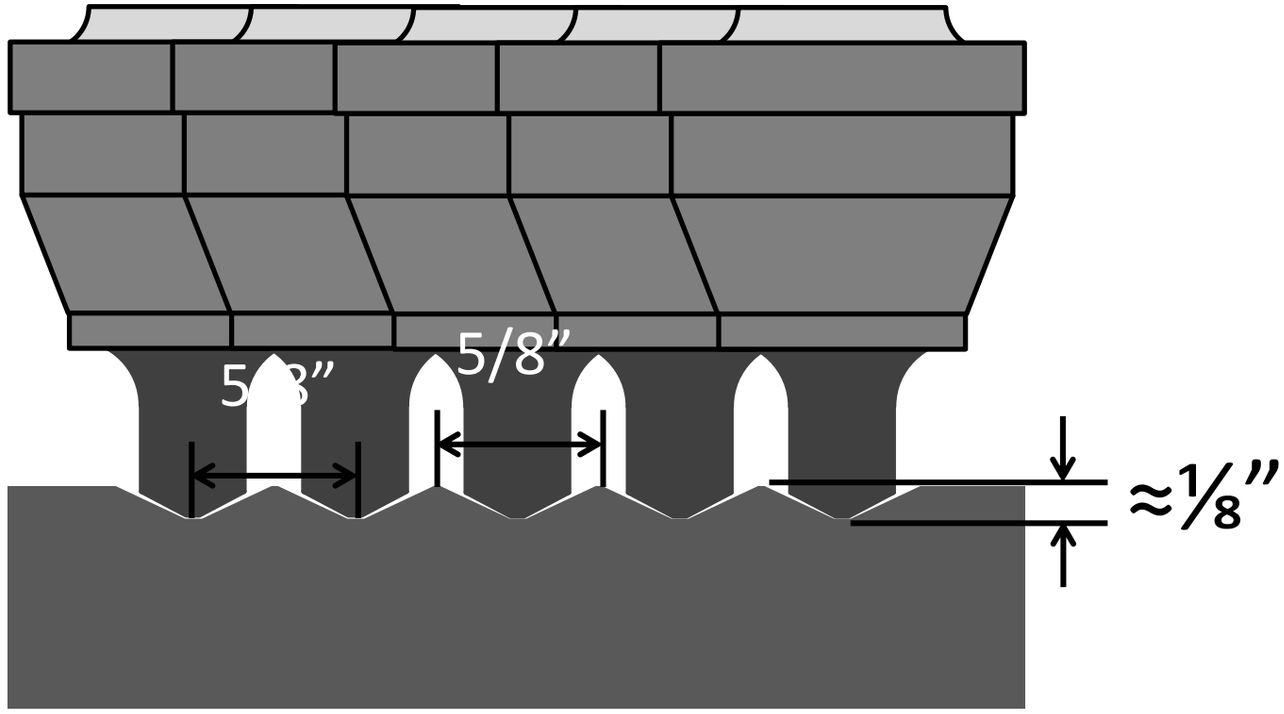
Line Spacing and Texture



Each cutter pattern is determined by the number of carbide teeth installed on the mandrel. More teeth produce fine patterns such as Profiling and Micro-Milling, but production rates remain low. Excavating and Traditional patterns allow for higher production rates but produce a coarser surface.

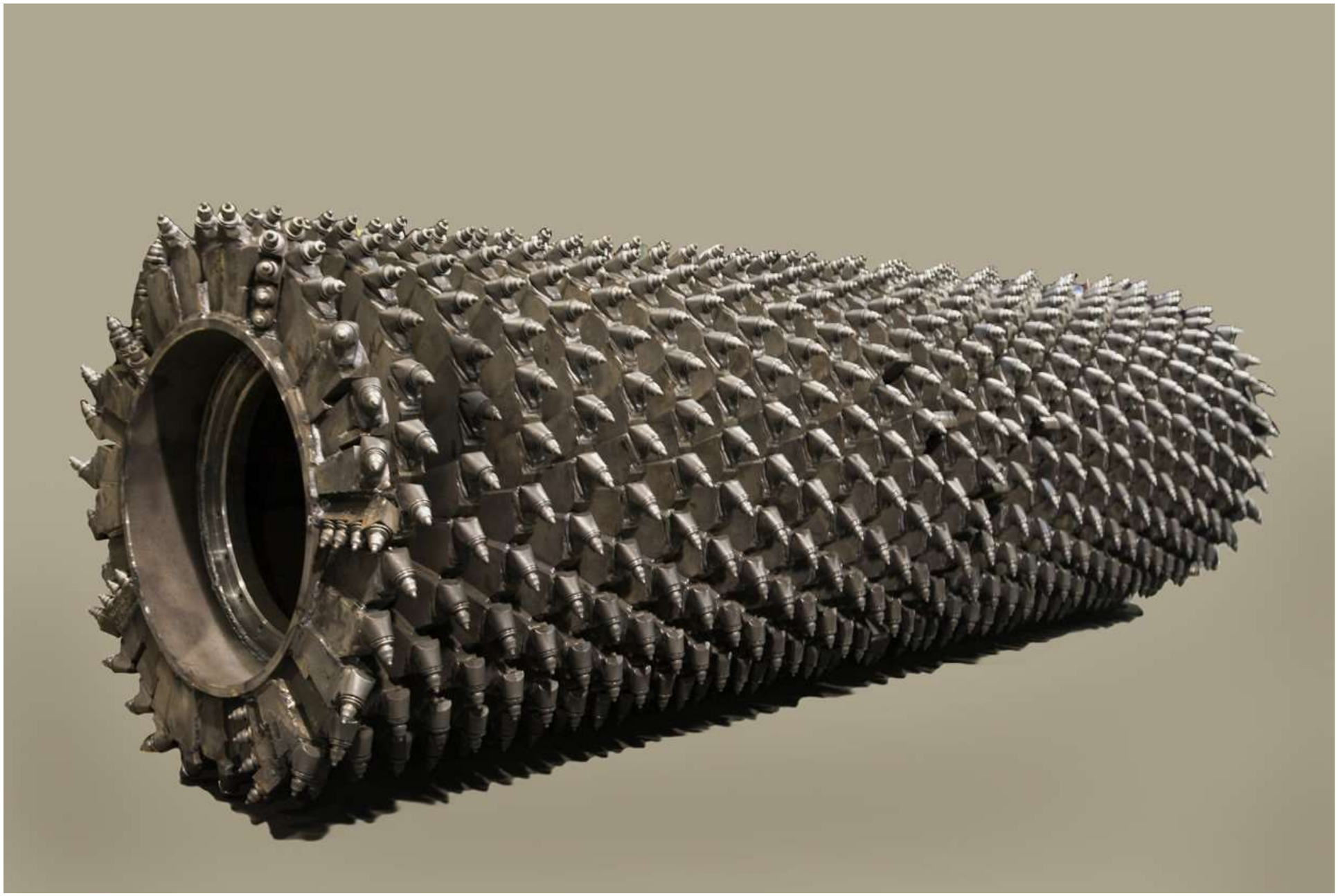
Milling Machine Cutter Drum Patterns

5/8” (16mm) Triple Wrap Lacing

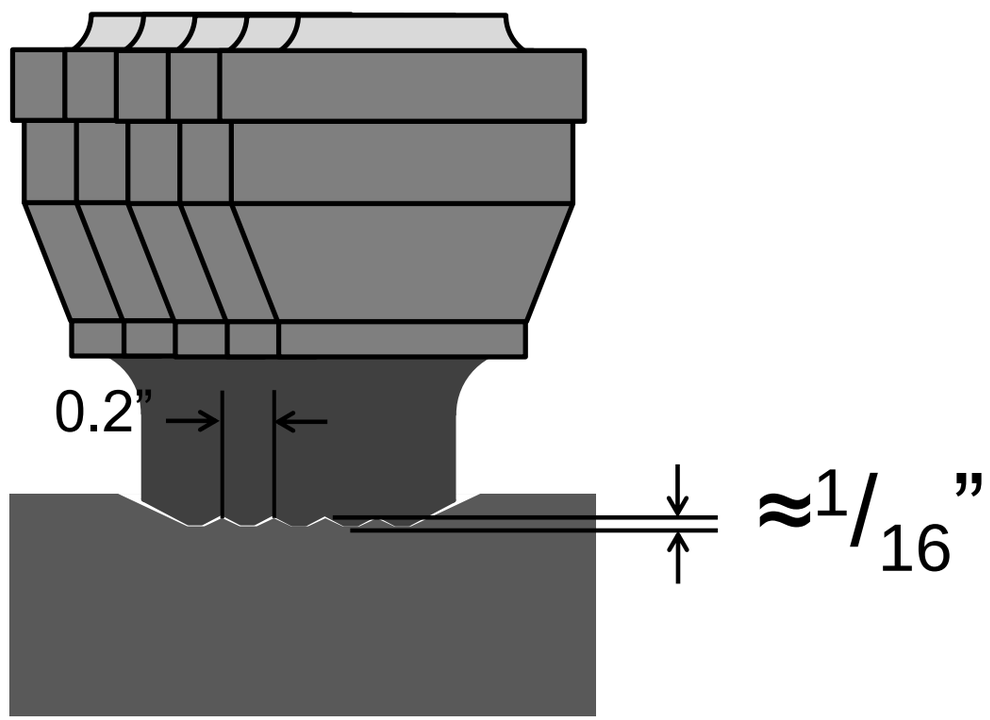


5/8” (16 mm) Triple Wrap at 30 fpm

Micro-Milling Pattern



2/10” (5mm) Quad Wrap Lacing



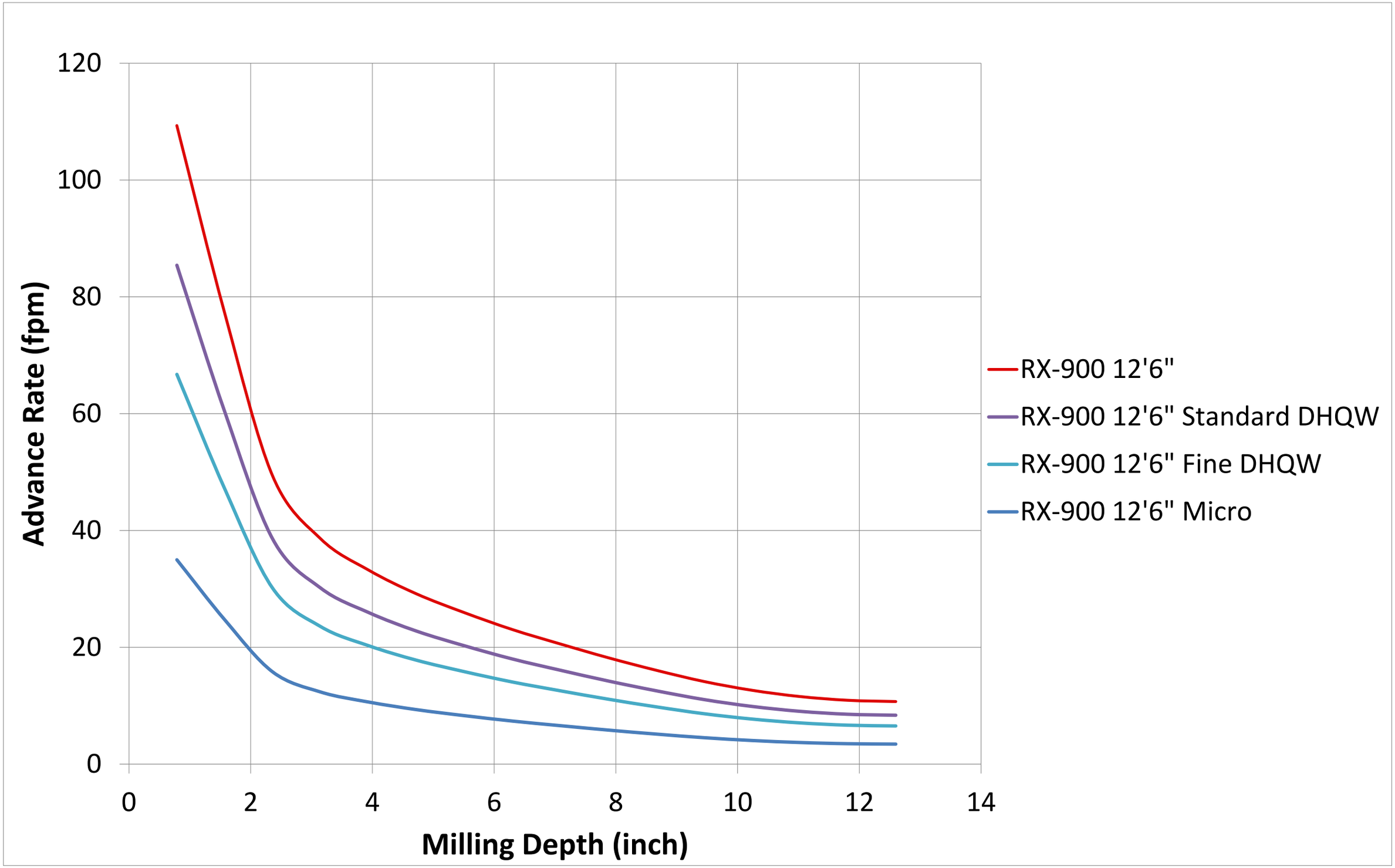
2/10” (5mm) Quad Wrap Lacing

Amount of Tools

12’6” (3.5 m) Full Lane Drum		
Line Spacing	# of Teeth	Cost of Teeth
5/8” (16 mm)	**268**	**$1340**
3/8” (9 mm)	**406**	**$2030**
0.2” (5 mm)	**770**	**$3850**

Nearly 3 times more teeth
Nearly 5 times the cost
No more quick change holders

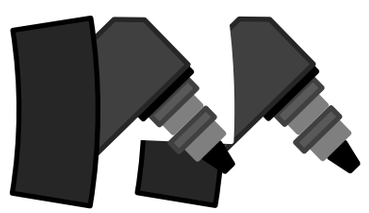
Production Tradeoff



Advance Rate = 30 fpm or 9 mpm

Advance Rate = 9 mpm or 30 fpm
Drum Diameter = 115 cm or 46”
Drum Speed = 100 rpm

Machine
Advance
9 cm or 3.6”
←



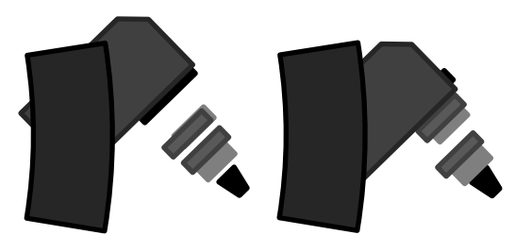
0.18 cm or 0.071”

30 fpm

Advance Rate = 60 fpm

Advance Rate = 60 fpm
Drum Diameter = 46”
Drum Speed = 100 rpm

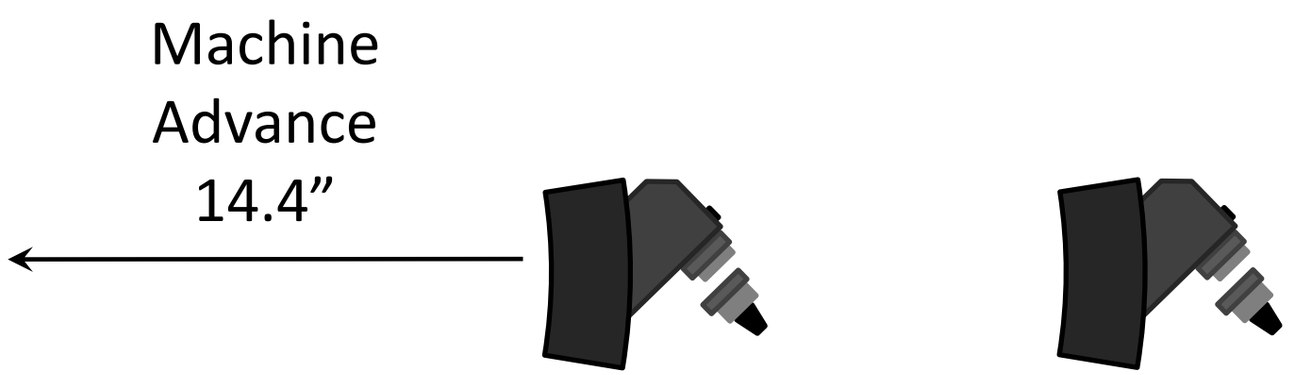
Machine
Advance
7.2”



60 fpm

Advance Rate = 120 fpm

Advance Rate = 120 fpm
Drum Diameter = 46”
Drum Speed = 100 rpm

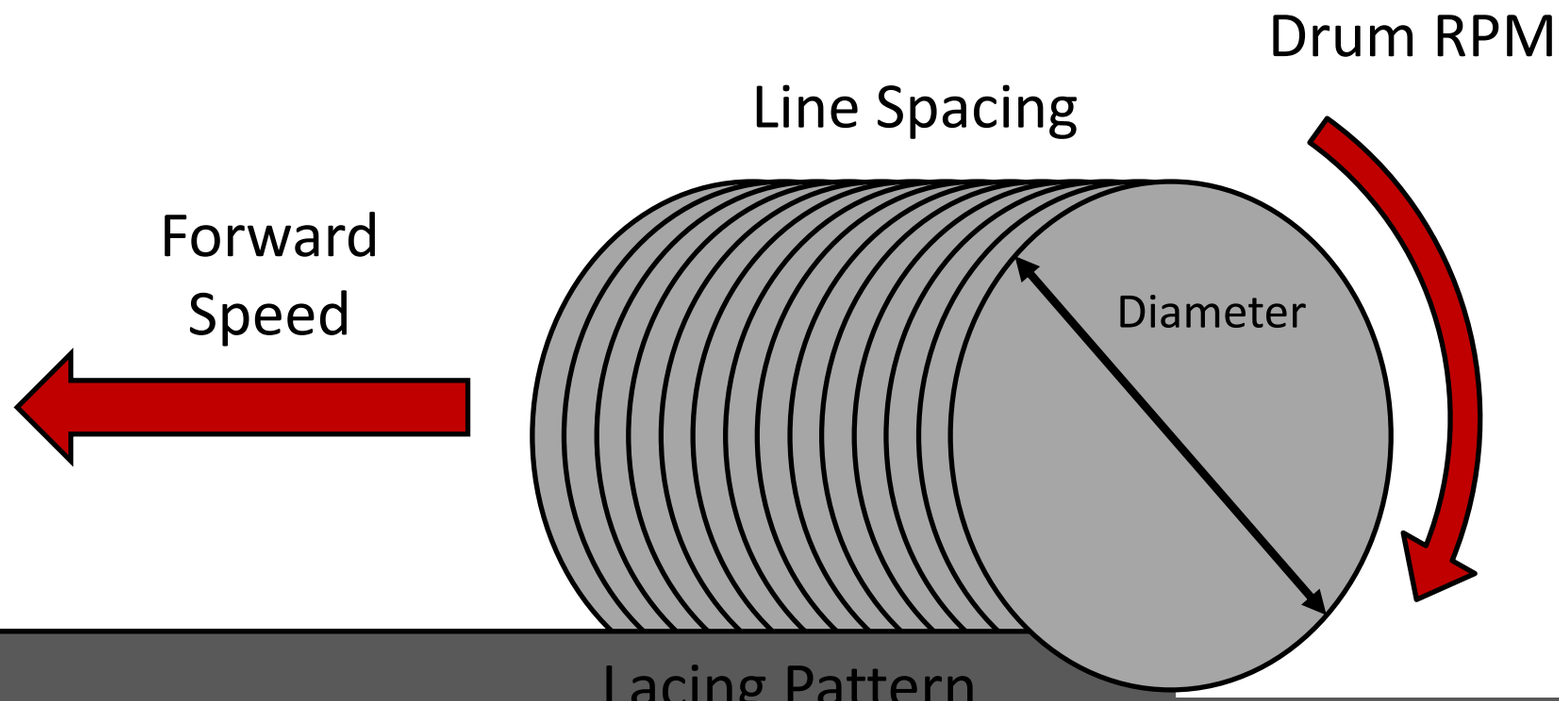


120 fpm

30 fpm vs. 120 fpm

2.3 miles in a day vs. 9.1 miles in a day

The Math of Milling



The 4 Main Factors that Affect Surface Texture

1. Line Spacing
2. Forward Speed
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Double Hit Drums

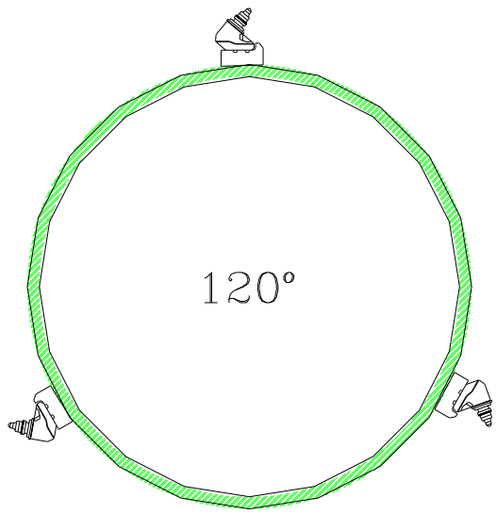
Above

Double hit Quad wrap drum

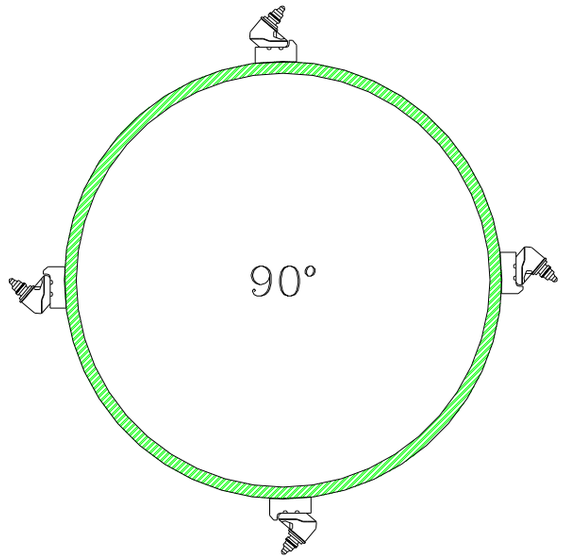
Standard triple wrap drum

Below

Drum Lacings
Scroll Start Comparisons

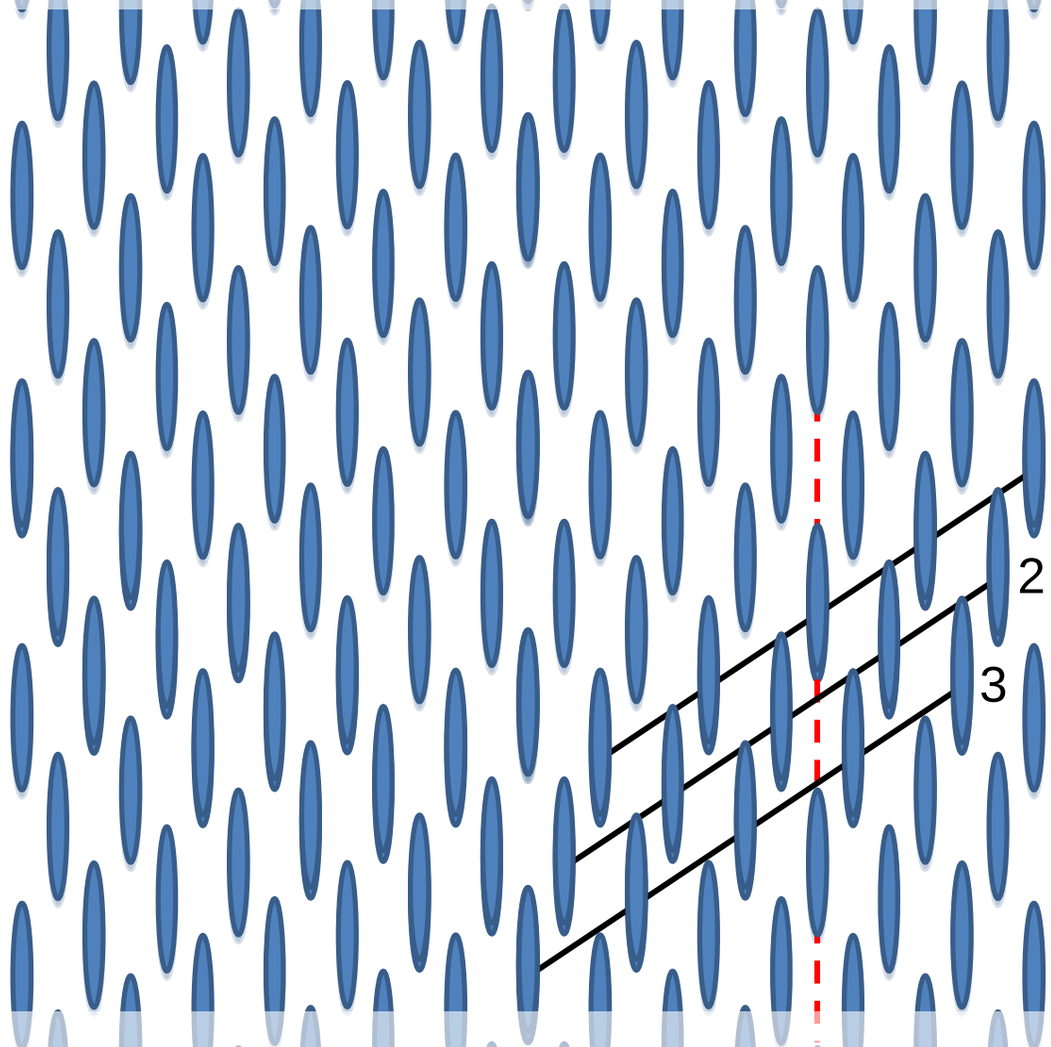


Triple Wrap

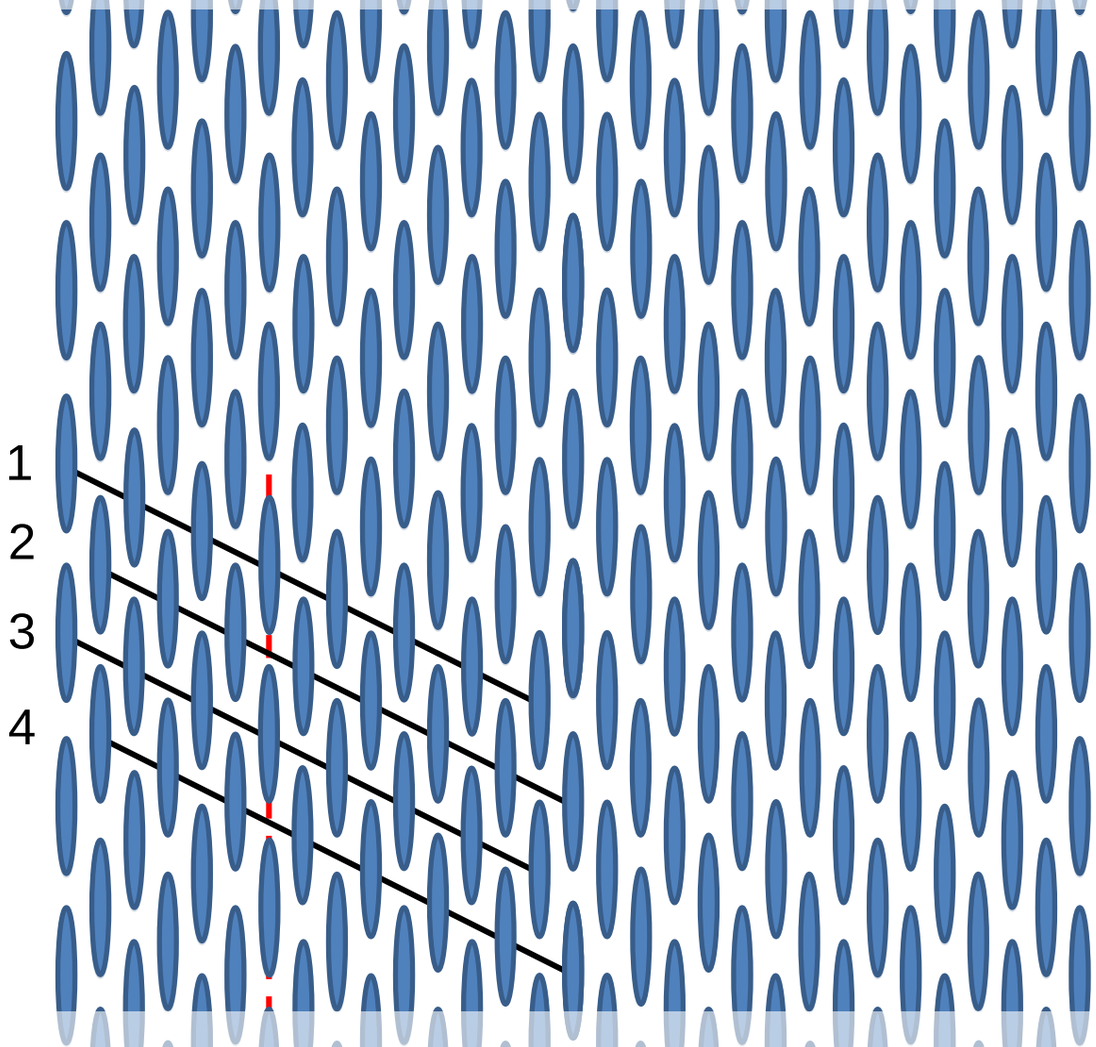


Double Hit
Quad Wrap

Pattern Comparisons



Single Hit
Triple Wrap



Double Hit
Quad Wrap

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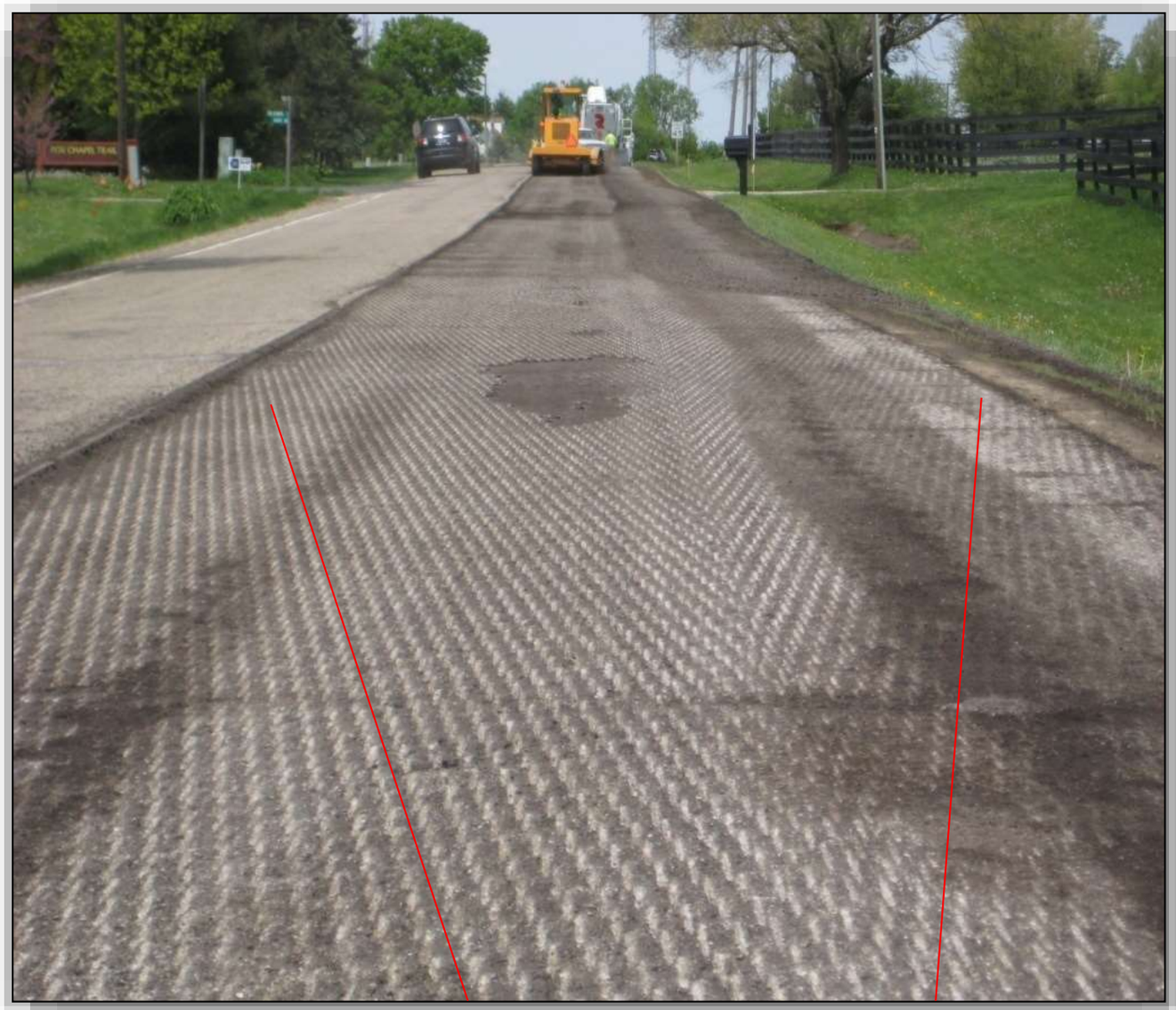

5/8” Triple Wrap at 100 FPM

7/8” DHQW at 100 FPM

Sand Patch Test ASTM E965

Indiana Glass Bead Test (ITM 812)

http://www.in.gov/indot/div/mt/itm/pubs/812_testing.pdf