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 as 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
Tool Wear Characteristics

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

- **Advance Rate (mpm or fpm)** vs **Milling Depth (cm or inch)**

  - **RX-900 New Teeth**
  - **RX-900 Stage 4 Teeth Wear**
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.
5/8” (16mm) Triple Wrap Lacing
5/8" (16 mm) Triple Wrap at 30 fpm
Micro-Milling Pattern
2/10” (5mm) Quad Wrap Lacing

≈1/16”
2/10” (5mm) Quad Wrap Lacing
## Amount of Tools

<table>
<thead>
<tr>
<th>Line Spacing</th>
<th># of Teeth</th>
<th>Cost of Teeth</th>
</tr>
</thead>
<tbody>
<tr>
<td>5/8” (16 mm)</td>
<td>268</td>
<td>$1340</td>
</tr>
<tr>
<td>3/8” (9 mm)</td>
<td>406</td>
<td>$2030</td>
</tr>
<tr>
<td>0.2” (5 mm)</td>
<td>770</td>
<td>$3850</td>
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</tbody>
</table>

Nearly 3 times more teeth  
Nearly 5 times the cost  
No more quick change holders
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
Drum Diameter = 46”
Drum Speed = 100 rpm
60 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
3. Drum RPM
4. Lacing Pattern
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
Pattern Comparison

5/8” Triple Wrap at 100 FPM

7/8” DHQW at 100 FPM
Sand Patch Test ASTM E965
Indiana Glass Bead Test (ITM 812)