



Milling: The First Step To A Smooth Overlay

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Volvo CE

Agenda

- Evolution of cold planing (milling)
- Drums
- Drum maintenance
- Grade/Slope controls
- Engine RPM/Drum RPM/milling speed
- Machine maintenance
- Macrotexture specification and test



Evolution of cold planing (milling)



Hot milling machine circa 1970

Evolution of cold planing (milling)

Evolution of milling in Indiana

- 1979 Started milling as an operation tool in the maintenance of asphalt pavements.
- 1985 Compiled a standard milling specification.
- 2000 The milling specification was modified to require milling equipment to include automatic grade controls to establish and maintain grade profiles.
- 2003 A surface macrotexture requirement was added to the milling specification.



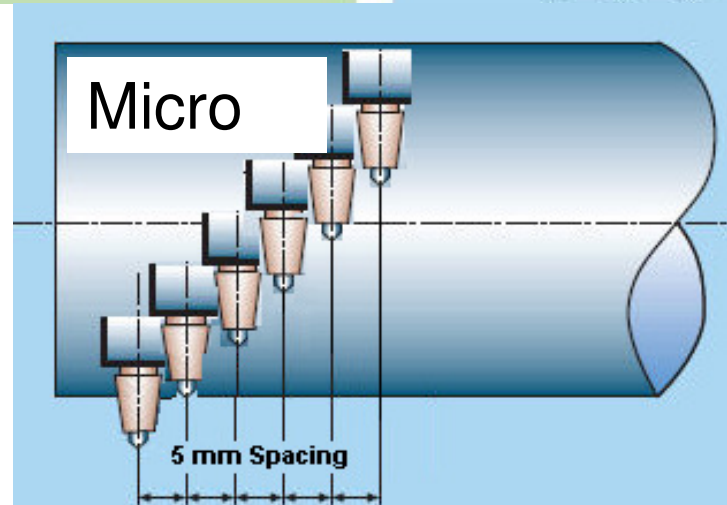
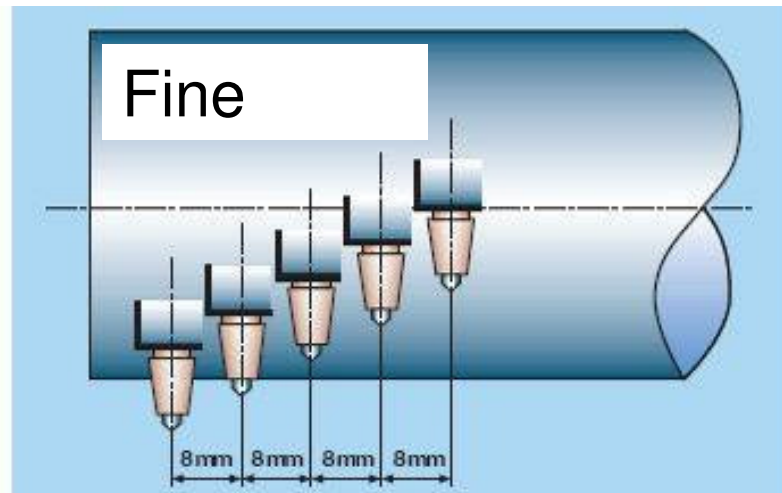
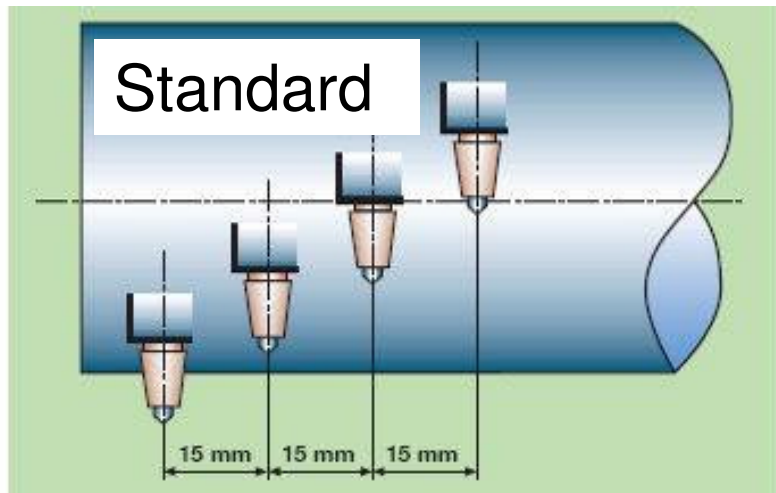
Drums

- Several different style of drums currently on the market
- Drum tooth spacing
- Typically 2 different types of tooth holder systems
- Scrolls or wraps
- Drum maintenance



Drum Design

Tool Spacing



Drums

- Typically 2 different types of tooth holder systems

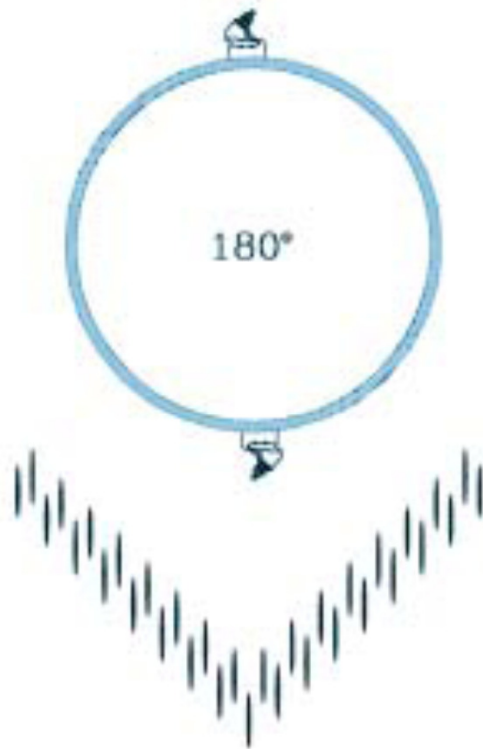


Quick change
holder system

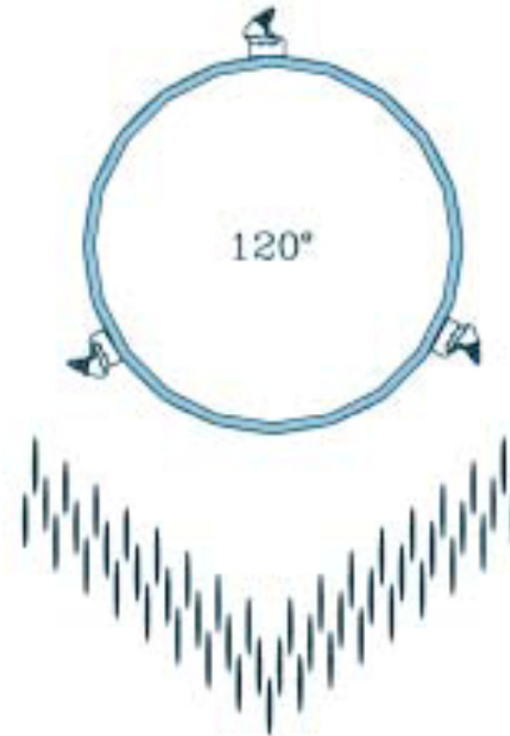


Weld-on holder system

Drum Wraps

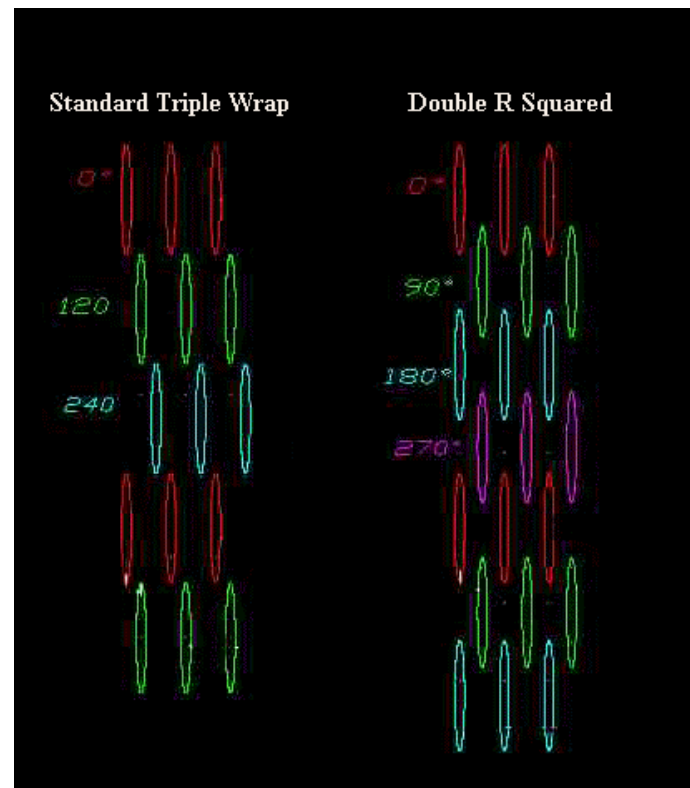


2 Wrap



3 Wrap

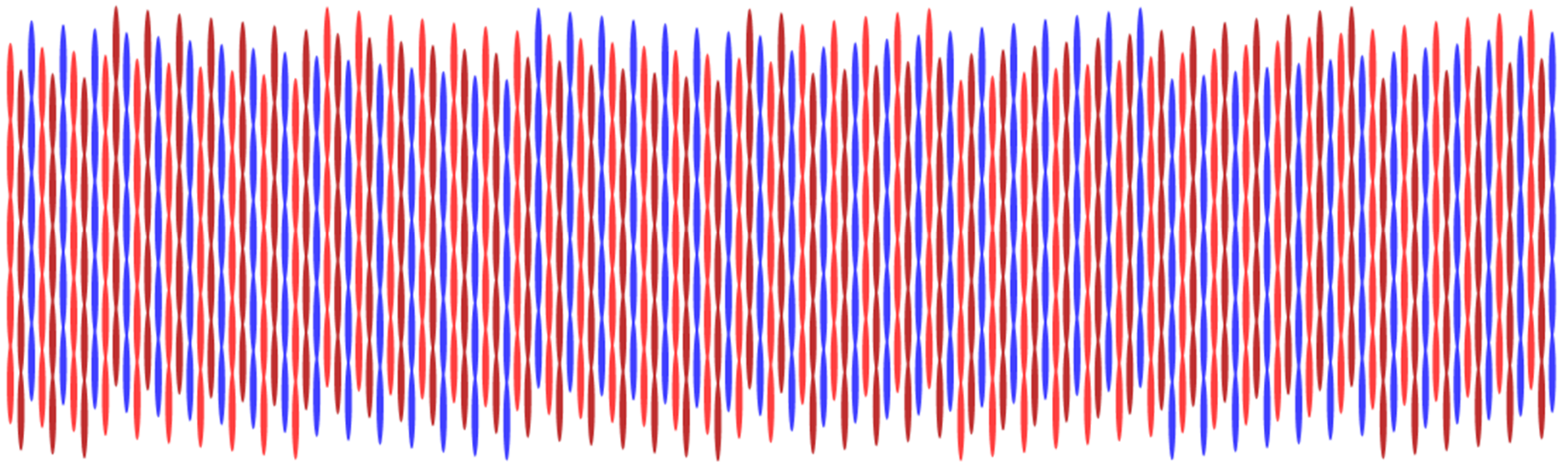
Drum Wraps



3 Wrap versus 4 Wrap

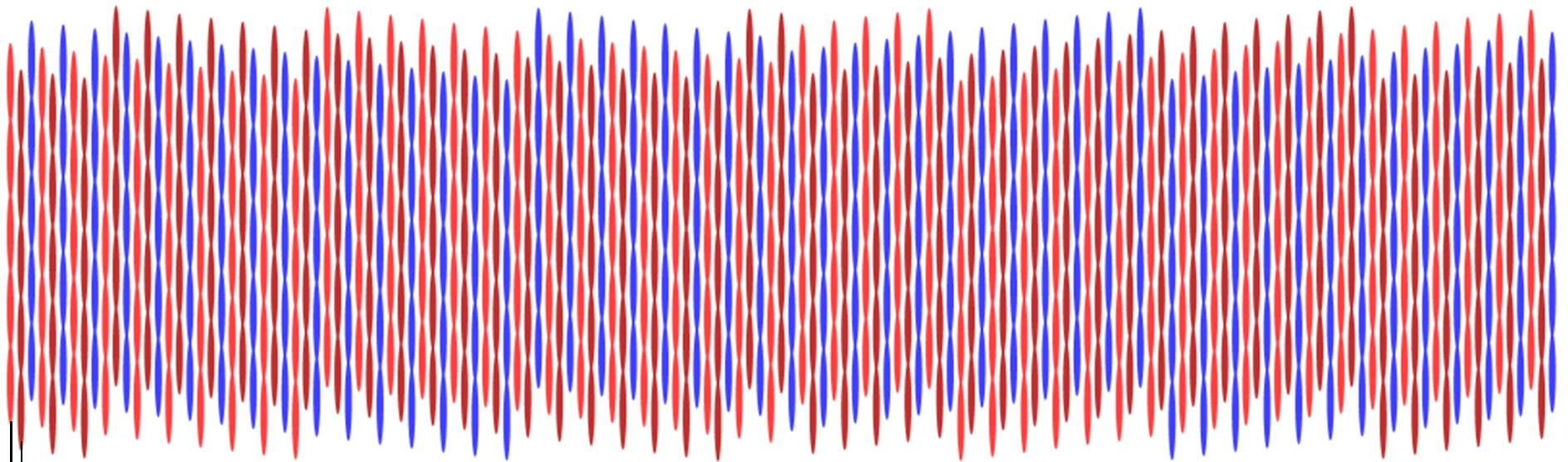
Drum Strike Patterns

15-3-1-35-100-3



Drum Strike Patterns

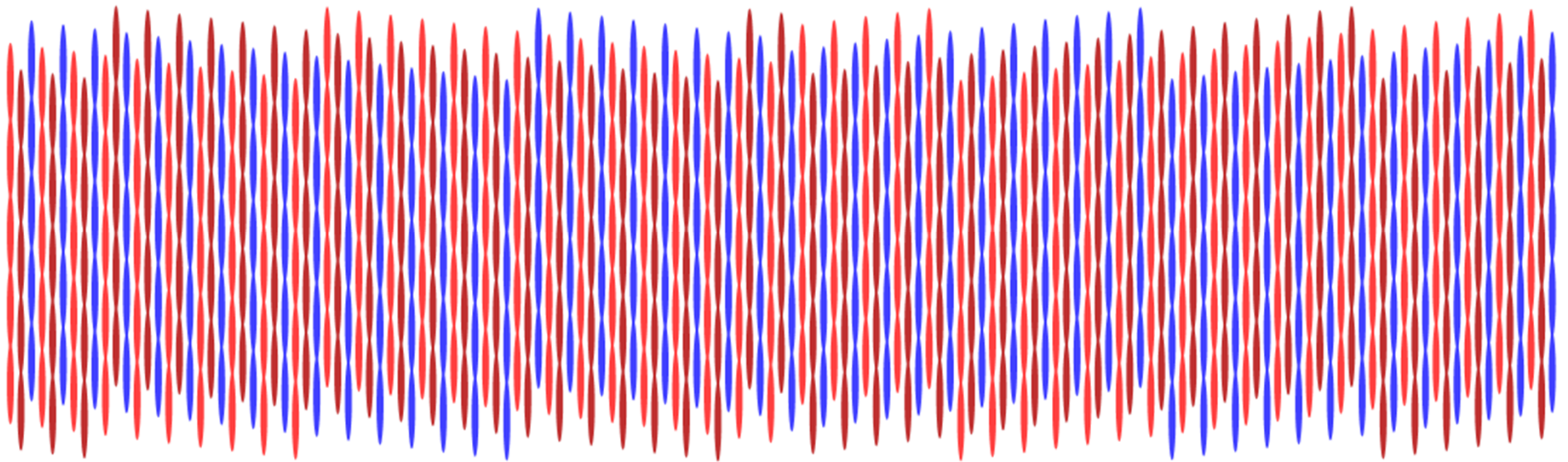
15-3-1-35-100-3



← 15mm Spacing between lines

Drum Strike Patterns

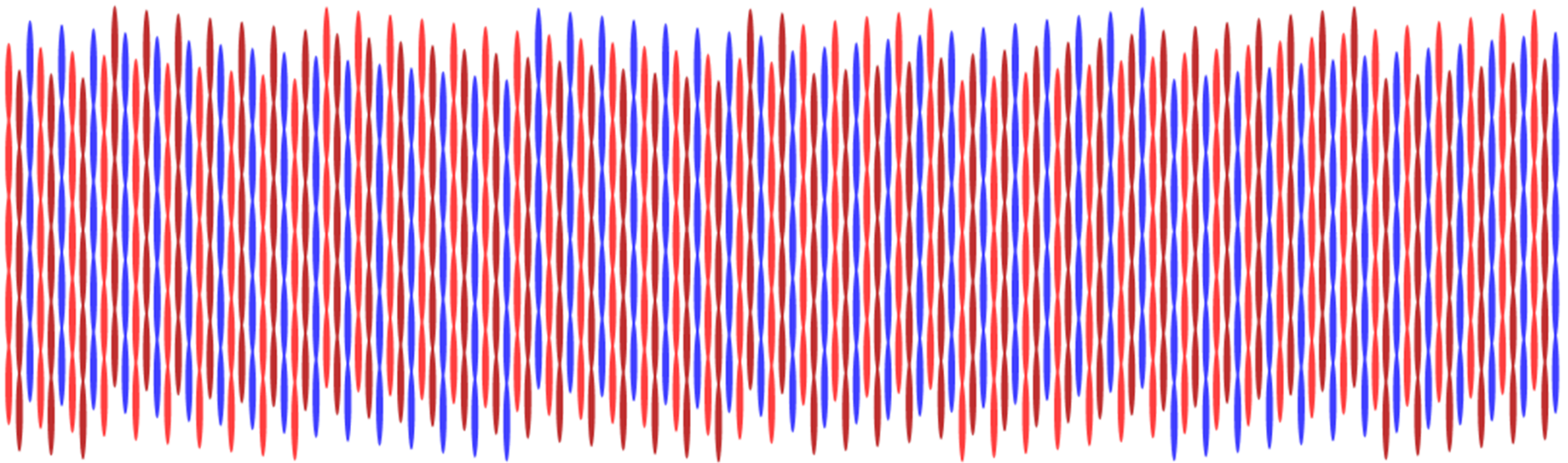
15-**3**-1-35-100-3



- 3 denotes the number of wraps
- Each color is a different wrap

Drum Strike Patterns

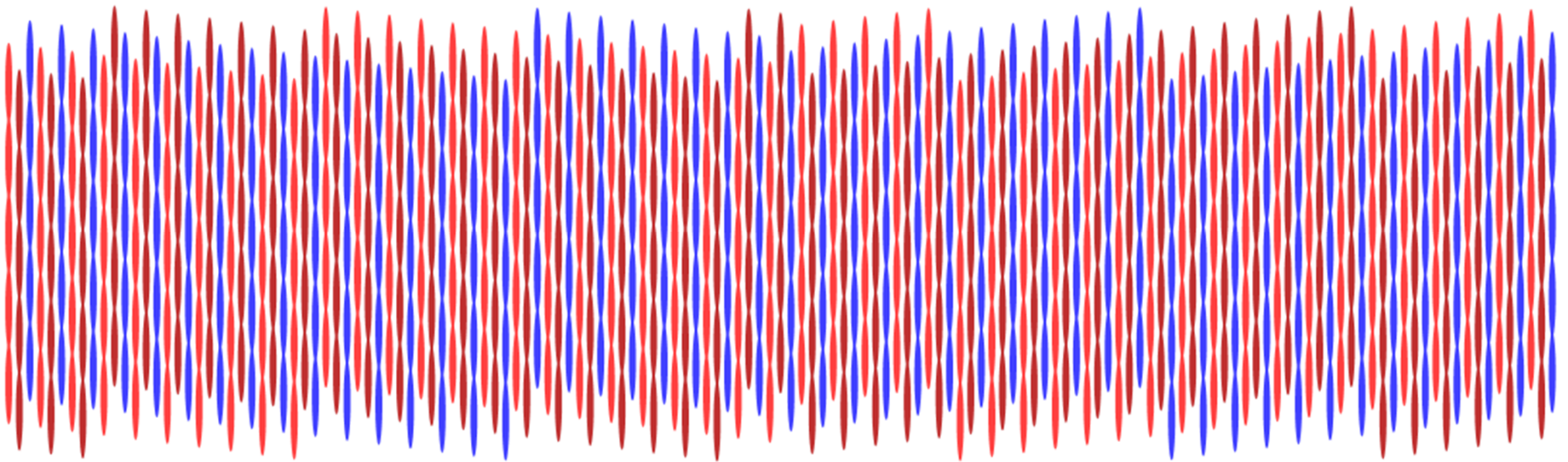
15-3-**1**-35-100-3



- 1 denotes the number of picks per line

Drum Strike Patterns

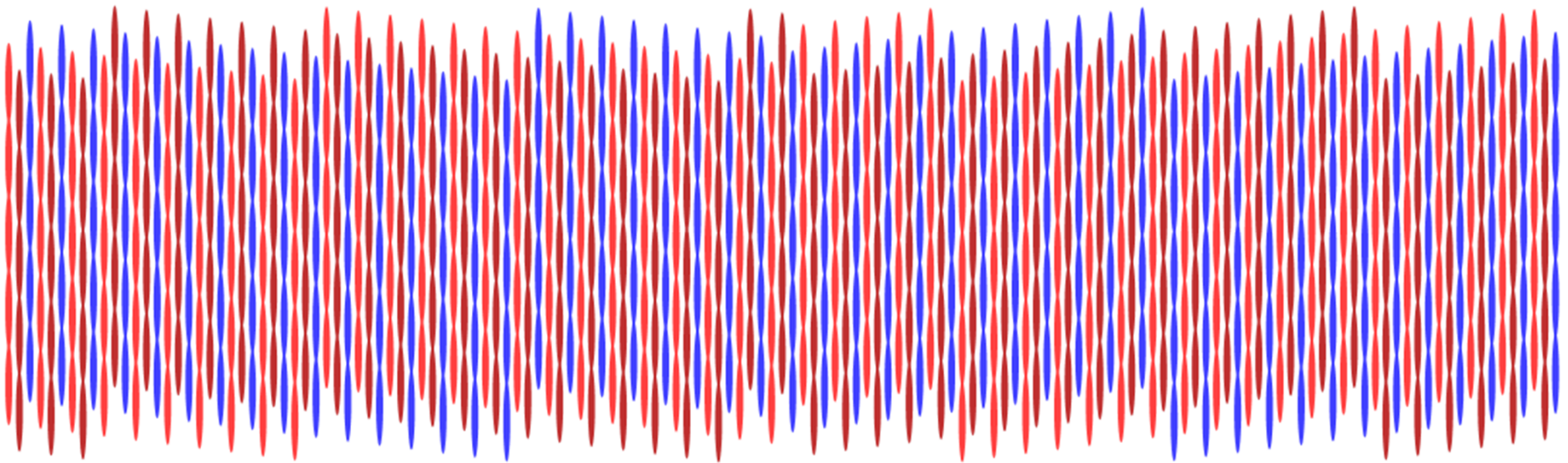
15-3-1-**35**-100-3



- 35 denotes the advance rate (FPM)

Drum Strike Patterns

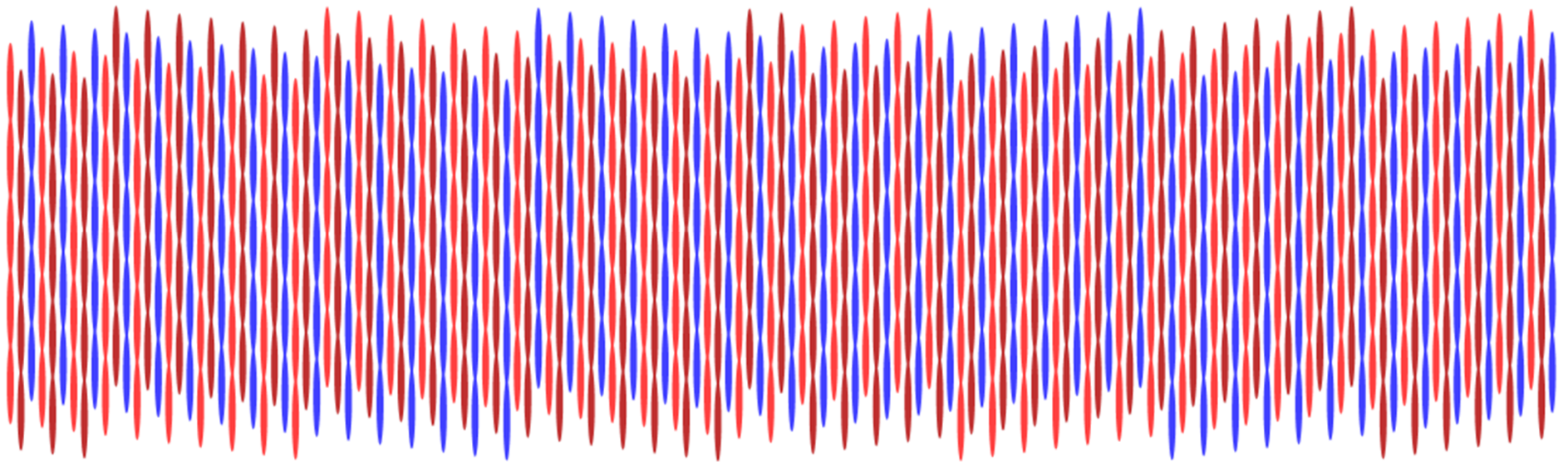
15-3-1-35-**100**-3



- 100 denotes the drum speed (RPM)

Drum Strike Patterns

15-3-1-35-100-**3**



- 3 denotes the depth of the tool mark (mm)

Drum Maintenance

- Changing teeth and tooth holders can have an adverse effect on pattern.
- Change teeth when they need it and change all the teeth
- Save used teeth for “spotters”



Drum Maintenance



Volvo Construction Equipment

North America Region

18 2014-03-28



Grade Control Components

MMI Machine Man interface



Grade Control Components

- Grade Control – Contact or non-contact control that senses the height of the material to be cut and sends a signal to make a machine correction in the depth.

Rope sensor



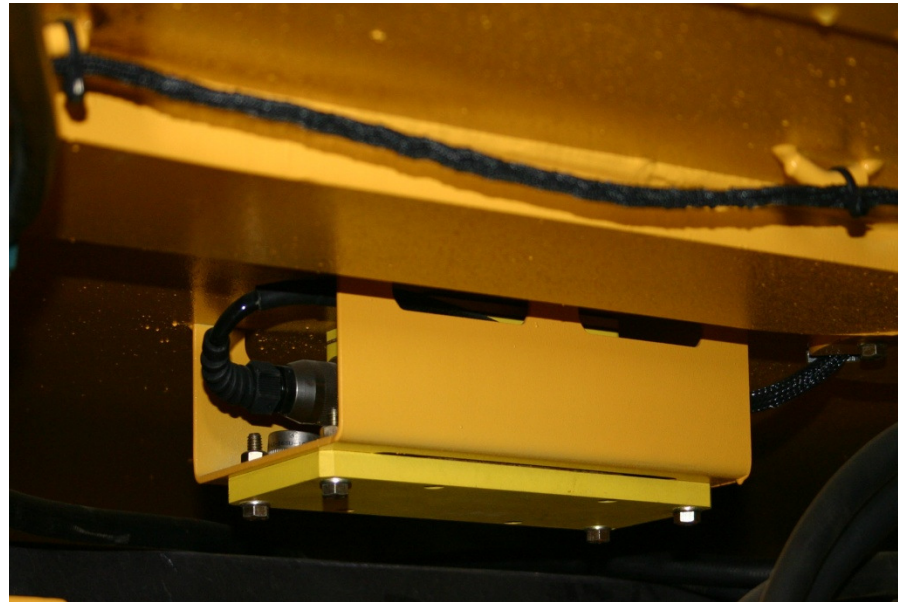
Sonic sensor



Slope Control

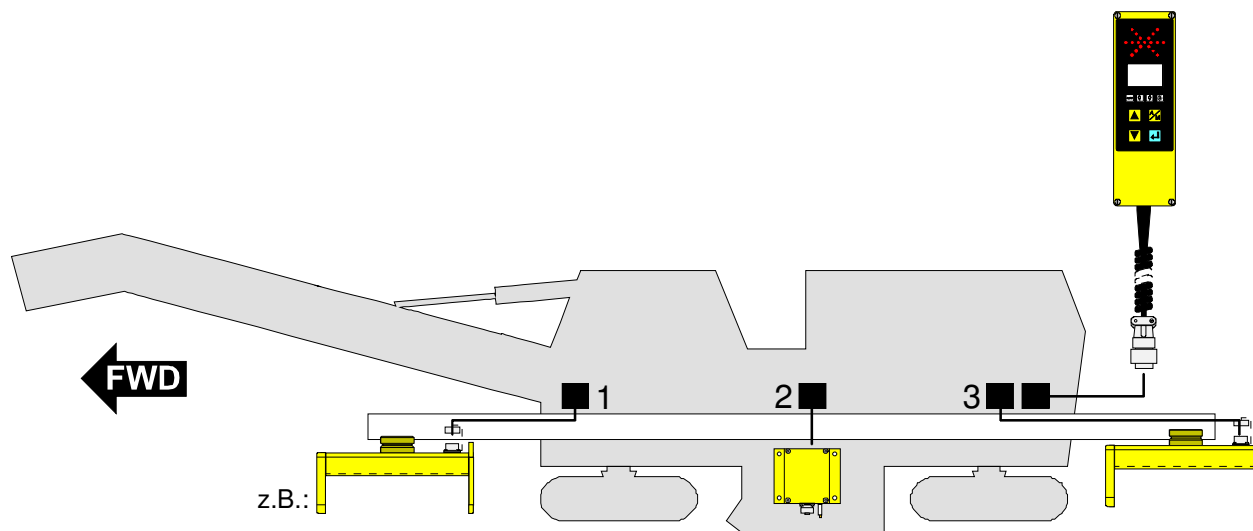
- Slope Control - Small sensor that is usually located on or near the drum box that senses the side to side angle of the machine and sends a signal to make a machine correction in the side to side angle of the machine. This control is a slave to the grade control.

Slope Sensor



Grade Control Options

Averaging Ski



Grade Control System

- Ensure your system is in good working condition before you arrive on the jobsite
- Adequately warm up your machine before starting the cut
- Adjust sensitivity to jobsite and weather conditions. In cooler weather hydraulics has a tendency to be slow until they warm up to operating temperature
- Remember slope sensitivity is usually adjusted lower than grade
- Know how fast your machine can run in slope before the machine out runs the slope control





Grade/slope control problem
sensitivity adjusted too high

Drum Speed vs. Travel Speed

- ARRA recommends a reasonable ratio of travel speed to cutter speed to maintain an acceptable level of quality.
- Most cutter drums turn at around 100 RPM.
- As the milling machine moves forward, a typical individual tool striation mark left in the surface of the asphalt is ~ 10 cm (3.5 - 4") long.
- If the travel speed in feet per minute is greater than the drum RPM, the machine is “outrunning the cutter”. When that occurs...



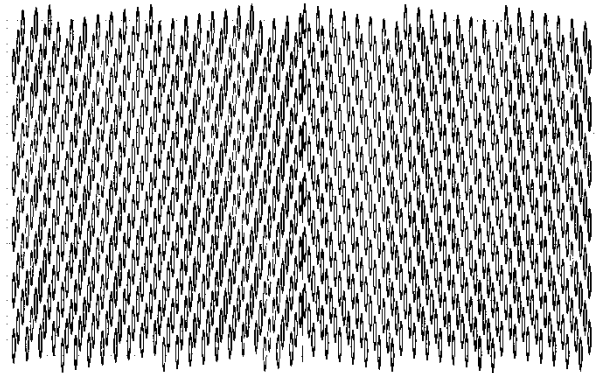
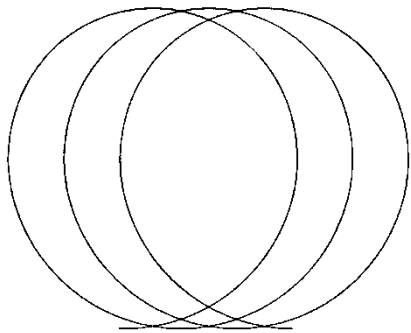
Drum Speed vs. Travel Speed

- ...Individual cutting tools are not overlapping their adjacent cut and a very poor quality, very rough textured milled surface results.
- The surface becomes scalloped and individually gouged.
- To maintain an acceptable level of production and quality, it is recommended that the travel speed in feet per minute not exceed $\frac{2}{3}$ of the cutter drum RPM.
- $100 \text{ RPM} > 20 \text{ m} (66 \text{ FPM})$.
- This allows $\frac{1}{3}$ overlap in cutting between adjacent teeth.



Quality vs. Quantity?

60 FPM





Scalloping due to excessive foot speed

Drum Speed vs. Travel Speed

- To increase drum RPM you must change cutter drive belt sheaves or increase engine speed.
- Increasing drum speed automatically is a new concept.
- This machine feature gives the operator a fast easy way to improve the texture of the cut easily and quickly.



Machine Maintenance

- Track pad wear
- Track chain and track roller condition
- Proper operation of water system
- “Loose” machine such as leg tube wear
- Conveyor system
- Side skirt wear shoes
- Cutter drum bearing
- Engine operation
- Propel system operation



Machine Maintenance

- Track Pad Condition
- Track Tension
- Track Rollers
- Leg Tube Wear



Machine Maintenance

- Water Spray System



Machine Maintenance



- Conveyor system



Surface Macrotexture Requirement

- Need for a method of testing the surface
- Glass bead test
- 3 states currently use this test for all milled surfaces
- Indiana helped develop the test in conjunction with AASHTO
- Other states are using the test in some instances



Testing Equipment



Glass Bead Test

- Randomly determine a sample location on the milled pavement surface
- Inspect the sample location and ensure the location is a dry, homogeneous site, free of unique or localized features such as cracks, joints, stripping and patching
- If localized features are present, move up-station at the same transverse offset until a suitable site is located
- Clean the sample location using the brushes to remove any residue, debris or loosely bonded material



Cleaning the Sample Location



Glass Bead Test

- Place a screen or suitable wind block on the milled pavement surface to protect the sample location from air turbulence
- Hold the container with filler above the pavement at the sample location at a height not greater than 4 in. (100 mm)
- Pour the measured volume of filler from the container onto the milled pavement surface into a conical pile
- Place the spreader lightly on top of the conical pile of filler being careful not to compact the filler



Spreading the Glass Beads



Glass Bead Test

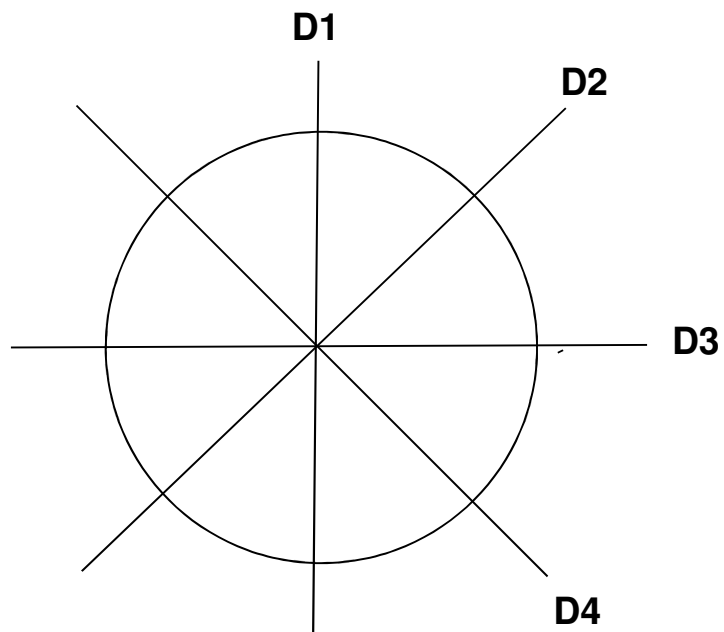
- Move the spreader in a slow, circular motion to disperse the filler in a circular area and to create a defined crest around the perimeter
- Continue spreading the filler until the filler is well dispersed and the spreader rides on top of the high points of the milled pavement surface
- Measure the diameter of the circular area from the crest of the slope on one side, through the center, and to the crest of the slope on the other side of the circular area
- Measure and record the diameter of the circular area four times, at intervals of 45° and to the nearest 5 mm



Measuring the Surface Diameter



Glass Bead test



- Measure 4 times at 45 degree intervals

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Glass Bead Test

- Calculate the average diameter of the circular area covered by the filler as follows:
where: $Da = \frac{D1+D2+D3+D4}{4}$
- Da = average diameter of the filler area in mm
- D1, D2, D3, D4 = diameters of the filler area in mm
- Calculate the Macrotexture Ratio from the following table using the average diameter of the area covered by the filler

MACROTEXTURE RATIO based on 200 ML of GLASS BEADS and AVERAGE DIAMETER

Avg. Diameter	Ratio	Avg. Diameter	Ratio	Avg. Diameter	Ratio
190	1.42	225	1.99	260	2.65
195	1.49	230	2.08	265	2.76
200	1.57	235	2.17	270	2.86
205	1.65	237	2.20	275	2.97
210	1.73	240	2.26	280	3.08
214	1.80	245	2.36	285	3.19
215	1.81	250	2.45	290	3.30
220	1.90	255	2.55	295	3.42

Review

Drums and Drum Speed

- Ensure your drum matches the job specification
- Know your drum speed in RPM in respect to engine RPM
- Most drum drive gear boxes are rated at 19:1
- Set your machine foot speed to $\frac{2}{3}$ of your drum RPM: 100 drum RPM / 65-70 FPM max
- If the job specifications call for slope your cutting travel speed should not exceed the machine's ability to make corrections.



Review

Drum Maintenance

- Spot check your teeth if you are not starting off with a new set
- If you change any teeth replace the bad teeth with used teeth. This will ensure the tooth height will be as close to the same as possible.
- Check your water system. This is the life blood for maximum tooth life



Review

Machine Maintenance

- Ensure your milling machine is properly maintained.
- The machine and its performance speaks volumes about your company and commitment to the business.
- If the milling job is completed with the “quality vs. quantity” theory utilized in the process it is the first step to a smooth overlay



Questions????

- Thank You For Your Time!







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