

PART 2 WINNING *the* BONUS

THE COLD TRUTH ABOUT COLD MILLING



Milling drum is the heart of the cold milling sequence; here worn cutting tools are replaced on the job site.

Image: Tom Kuennen

This month, *Equipment World* launches a new seven-part Road Science series on how to optimize pavement construction to win those bonuses.

We start at the very foundation of the overlay, the milled asphalt surface, and then look at each aspect of paving both asphalt and concrete pavements:

Part 1: Smooth Pavements through Cold Milling

Part 2: Smooth Pavements and Material Transfer Vehicles

Part 3: Smooth Pavements and Asphalt Pavers

Part 4: Smooth Pavements and Asphalt Screeds

Part 5: Compaction for Super Smooth Asphalt Pavements

Part 6: Super-Smooth PCC Pavements with Slipform Pavers

Part 7: Super-Smooth PCC Pavements with Stringless Controls

A milled surface with the right pattern, grade and slope is the key to a super-smooth asphalt overlay that wins the smoothness, density and performance bonuses (now so critical to contractor profitability).

In just over three decades, asphalt cold milling equipment, also called planers or grinders, has matured in terms of durability, complexity and choice of makes and models.

Operators are under pressure to get the best performance out of their cold mills in terms of consistency of

milling pattern, correct grade and slope, cleanliness of cut, consistency of millings and cost-effective use.

That's in addition to their obligation to maintain uptime for an expensive and critical piece of mobile equipment used in an extremely abrasive application. If a cold mill goes down on a job, it can result in substantial project cost overruns and even nightmarish disincentive payments for failure to complete a critical time-sensitive job on schedule.

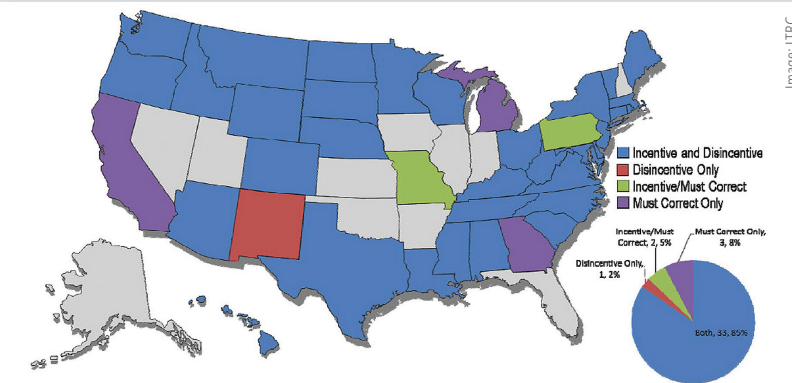
The milling drum, or mandrel, is the heart of the cold milling sequence. It's the axis around which the entire milling process revolves. A well-designed and well-maintained cutter drum will help the operator in his mission.

"Cutter technology and the way they build the drums is much more advanced than in past years," says Jeff Wiley, senior vice president of Wirtgen America. "A drum is built today to nearly the same precision as a fine Swiss watch. The drums are all turned using laser technology. When these drums are assembled new, they are spot-on, with no chance for error."

Aside from breakdowns, the proof of success will be in the cutter pattern. Variables in control of the cutter pattern involve several elements, including the condition of track pads and the cutter drum, tooth spacing, the cutter tooth and holder condition, the cutter rotation speed, the cutter wrap (tooth pattern on the drum) and tooth spacing. Other variables include the grade control system, the existing pavement condition, the ground speed, the availability of water for dust control and tooth rotation and the overall condition of the machine.

Even the housing around the cutter drum is under continuous refinement. "The industry standard has moved to an angled mold-board wrapping around the cutter

Smoothness: A moving target



Summary of incentive/disincentive schemes for asphalt pavements

There are real reasons behind the states' demands for smooth pavements.

Surveys consistently show that smoothness is the No. 1 criterion by which road users judge pavements. Pavements that are built smooth, stay smoother longer, and provide a longer life, according to engineering reports. That's why state DOTs know that building smooth pavements from the start is a cost-effective proposition. State DOTs routinely employ smoothness specifications in their regulations, and are basing contractor payment incentives or disincentives on achieved pavement smoothness.

The two most commonly used smoothness indexes are the **International Roughness Index (IRI)** and the **Profilograph Index**. A lesser-used method is the **Ride Number**, an index that estimates user perception of ride comfort, indicated by a number between 0 (poor ride quality) and 5 (excellent ride quality).

With the early popularity of the profilograph, the profile index became a standard index for smoothness measurement in construction specifications. Profilographs are relatively inexpensive, simple to operate and maintain, and display a "trace" of the pavement surface that users can easily understand. However, because of its wheeled configuration, it can't be used for high speed network pavement smoothness data collection.

Alternatively, the vehicle-mounted inertial profiler that measures pavement smoothness while driving at highway speeds, is replacing the profilograph for gauging smoothness, and is used in compiling IRI-based specs.

In a April 2015 report, the Louisiana Transportation Research Center (LTRC) studied state smoothness specs, and confirmed that states are moving away from profilograph-based smoothness specifications to, IRI-based specs. But this change is complicating the contractor's job, since there's a limited history in using IRI-based specs, leading to some confusion on how states can best

structure specifications. "Additionally," says the report, "contractors accustomed to profilograph-based specifications can struggle to achieve the same level of quality under IRI-based specifications."

LTRC researched the state-of-practice for IRI-based specifications, and summarized how both asphalt and concrete road builders could best achieve these specifications. It concluded that:

- Of the states with IRI-based specifications, 85 percent provide incentive and disincentive pay adjustments for asphalt pavements, while 78 percent provide these adjustments for concrete pavements.
- There is still a fairly wide range of IRI thresholds for incentives, disincentives, full pay, and correction and no general consensus on what thresholds are most appropriate.
- There is a wide range of pay adjustments for pavement smoothness, with the majority of states applying pay adjustments on a dollar amount-per lot basis versus a percentage of the contract price.
- Although most states have localized roughness provisions, there are a variety of localized roughness methodologies used, and no general consensus as to which is best.

"It's important to note that pavement smoothness specifications and practices are effectively a moving target," LTRC reported. "Agencies are continually refining specifications based on evaluations of existing programs and improved technology."

The methods used to judge pavement smoothness – as part of acceptance testing for new or reconstructed pavements – are growing more refined. Also, the equipment used to obtain smooth pavements during construction is improving as digital and laser technology improves.

housing,” said Eric Baker, Roadtec director of marketing and sales support. “This makes sure less material dwells in the cutter housing, just turning around in the drum, and makes it on the belt quicker. Another benefit is a cleaner cut and less wear, promoting a longer cutter life.”

Mills previously used hydraulic and chain drive cutters, and the track system had no flow dividers. Most machines had three tracks, or legs, and were equipped with hydraulic grade sensors. Typically, the horsepower range was 300 to 525.

Cutter drums now are powered by belt drives with automatic tensioners. Track systems have flow dividers for optimum power where it is needed, and four-track units are widely available.

Today, only the smaller units are rear-load designs; instead, front-loading conveyors work in full view of the operator, boosting productivity for middle and larger-sized machines. More than 90 percent of the machines have electronic grade and slope controls. And power ratings up to 1,200 horsepower give more muscle to deep cutting and even permit milling of concrete pavements and bridge decks.

Focus on fine milling

So called “fine milling” – in which cutting bits on the drum are spaced at 5/16 inch instead of the conventional 5/8 inch – is now getting more attention – as thin surfacings and overlays become more popular. Fine milling can also be used

on driving surfaces to restore friction and smoothness.

If the following overlay project is delayed, fine milling is an advantage, as it’s easier on the traffic. The fine milling brings added costs, since it requires more teeth and wear components. But, it also brings definite performance advantages.

Fine or micromilling in advance of an overlay enhances adhesion, removes any significant poor ride quality, and if done right, can produce a level surface that provides the super-smooth riding experience that drivers demand.

“Consider installing a high density drum on the cold planer for projects that have tight smoothness specifications,” said Randy Dobson, Caterpillar, in recent remarks. “Whereas the impact spacing is 5/8



A fine-tooth drum provides super-smooth substrate for interstate overlay.



inch (16 millimeters) on standard cold planer drums, the impact spacing is reduced to as little as 1/4 inch (6 millimeters) on the highest density drums. There is a higher operating cost associated with high density drums, but the smoother surface created may offset the financial consideration.”

While thin surfacings such as microsurfacing (and thin-lift, hot mix asphalt overlays) provide a durable driving surface, their thinness makes them vulnerable to variations in the pavement substrate on which they are placed. The evenness and smoothness of



Image: Tom Kuennen

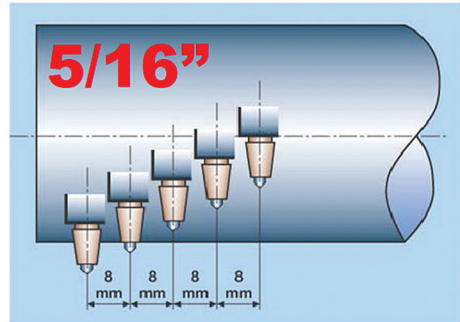
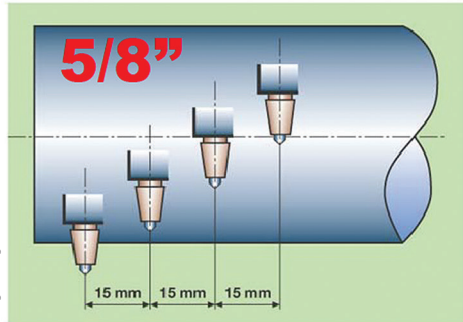
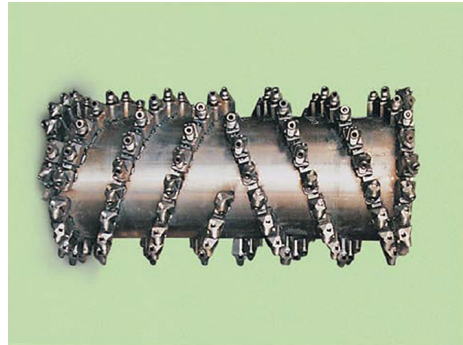


Image: Wirgin America



Standard drum tooth or cutting tool spacing compared to fine tooth spacing.

these thin surface treatments will depend mostly on the smoothness of the prepared surface. That can be ensured by cold milling the existing, worn surface with a fine-tooth drum.

With a conventional drum, relative to ground speed, the ‘peaks-and-valleys’ mill patterns will be relatively high and deep. If you place a lift that’s only 1 to 1 1/4-inches thick, the rough surface can reflect through to the paved surface. But, by using 5/16-inch bit spacing (or less) – the definition of a fine-toothed drum – a contractor can minimize this potential reflection.

Milling pattern performance is so critical, a test has been developed for job performance. The spec determines the roughness of a milled pavement by placing glass beads on the surface, which are then carefully spread out using a clear plastic disk.

For the test, from a maximum 4-inch height, 200 milliliters of

glass beads are poured onto the milled surface, and then distributed evenly using a slow rotating motion with a plastic disk until the disk rests on the points of the milled surface.

For fine milling, by the time the plastic disk comes to rest on the peaks of the milled surface, the bead pile must have spread at least 9.5 inches in diameter, indicating a fine pattern; if they spill too quickly, not achieving the required diameter, the pavement is too rough and must be remilled.

Full-lane milling

Full-lane milling with a fine texture drum will help attain an even smoother surface. For example, a 12.5-foot-wide drum removes a full lane at one pass, with no slow-down of the machine or its power plant. When the full-lane-width milling head is combined with a fine-tooth drum, the result is a smooth substrate for overlays

and potential bonuses for meeting stringent smoothness goals.

In addition to the fine texture from the drum, the full-lane width drum permits extraordinary control over the outfall of the milled surface, which contributes greatly to exceeding smoothness specs, and perhaps, to a bonus.

Even though the milling head protrudes beyond the frame on the right and left, there is no disadvantage to using the wider milling head. Instead, it makes the machine more versatile and profitable on large volume jobs compared to the standard 7.2-foot drum. The number of machine passes for a road is reduced, with fewer turns for additional passes, which is ideal for night work or work under extreme traffic conditions.

Fine-tooth milling also provides a smaller, more uniform size of reclaimed asphalt pavement, such as minus 1.5 inch. This means it may not have to be crushed, but only screened, prior to recycling at the plant. The size of the material depends on the speed at which you mill, but a fine-tooth drum will always give you a smaller particle size than a conventional drum. The more uniform the particles, the more RAP can be incorporated into fresh hot mix asphalt.

Keep it moving

Similar to using a material transfer vehicle in asphalt paving, a major secret to milling for smoothness is to keep the mill moving.

Planning a job each day is a key component of higher productivity, requiring the optimally efficient use of trucks.

Operators should think through the project the way a paver operator



Image: Caterpillar

Milling machines offer same slope control capability as an asphalt paver.

does, planning production for the day. Going a quarter-mile – then waiting for trucks – is inefficient. Making sure enough trucks are available is essential for a full day’s production. A machine fills up a truck up fast these days, and any down time is money down the drain.

The milling operation should actually mill and load trucks at least 40 to 45 minutes out of the hour, experts say. Therefore, the operator needs to balance the trucks, pacing himself a bit, and keeping the machine running steady (instead of running the machine wide open, then waiting 15 to 30 minutes for

trucks to return), especially if working in congested traffic.

In addition to balancing trucks, speed of forward movement can affect the quality and evenness of the cut. As long as the bid is all about production, the machine has to run at a high rate of speed. But, high speeds don’t necessarily mean a high-quality cut. The faster you go, the worse the pattern gets. The rougher the texture, the harder it will be to maintain smooth grade with the milling machine.

“The more consistent a machine’s speed, the better off the operator will be,” Wiley said. “It doesn’t make sense to run at

full speed, slow down and stop, change trucks and run at full speed again. That changes the milling pattern significantly; you are better off running at a slower, more consistent speed, as it will result in a more precise pattern or texture of cut, and that will benefit the paving operation.”

Another way of keeping a cold mill moving without stops is replenishing water (used to cool the teeth and suppress dust) on-the-fly, without stopping. While the mill moves forward, a water truck moves with the machine, filling its water tank.

The human element is a big part

of productive milling, and keeping crews with a single machine over time will boost performance. When crews stay on a machine month after month, year after year, they understand it, they know what to do on the machine to keep it up and running, and will remember any issues or problems with the machine. While cross-training of crews is desirable from a staffing point of view, having new crews all the time is not good for a milling operation. The best crews are those that have been with the machine for the life of the machine, because they come to treat it as their own.

Grade and slope controls

The variety of grade and slope controls available to operators of cold mills is broad, but they all assist operators in achieving smooth,

predictable cuts.

The grade control is a 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, says Rob Hannan, district sales manager for Volvo Construction Equipment.

The slope control, on the other hand, is a 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 that side-to-side angle. "This control is a slave to the grade control," Hannan says.

Hannan offers these tips to accurate cutting:

- **Ensure your system is in good working condition** before you arrive on the jobsite, and adequately warm up your machine before starting the cut.

- **Adjust system sensitivity** to jobsite and weather conditions; in cooler weather, machine hydraulics have 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. "Every job is different, and the operator today has the opportunity to select the type of grade control system he wants to use," Wiley says. "It could be a laser system, running off stringline, GPS, dual-grade, grade-and-slope, averaging, averaging with three sensor heads, or with seven sensor heads." "The cold planer has the same slope capability as an asphalt paver," says Dobson. "Whenever

possible, the cold planer should use automatic slope control to create specified profile."

The typical set up of Caterpillar's Grade and Slope feature for cold planers uses more data samples than other systems, he says, providing a more accurate representation. Plus, cross coupling capability improves machine responsiveness, providing both surface quality and accuracy. Automatic calibration ensures consistent setup and delivers optimal performance, and an intuitive operator's display makes the technology easy for crews to leverage in real-world, on-the-job conditions.

Wirtgen's new Level Pro Plus grade control automatic leveling system is user-friendly and regulates the pre-set milling depth and inclination electronically. The complete system consists of combinable sensors, a controller unit and an ergonomically designed control panel for the machine operator.

This grade-and-slope control system is integrated into the machine control system. The preset target milling depth is accurately controlled via robust displacement sensors located in the hydraulic cylinders, which are mounted on the side plates.

All key data – including the acquisition and indication of job data – are indicated in color on the operator display in the individually adjustable, multi-functional armrest. Four "favorite" buttons – which can be programmed with 15 different optional functions – have been integrated in the multi-functional armrest for the first time.

Roadtec's SmoothMill system features integrated connections and cabling and two dual control boxes for ground personnel, each capable of controlling both sides of the machine while giving the operator (driver) a separate control box.


The sonic sensors scan the surface 40 times per second and produce a signal that automatically adjusts the leg tubes of the cold planer so the resulting milled surface will conform to spec.

Ease of use comes from being able to simply plug controls into sockets (conveniently located on the

outside of the machine) and from combining right and left-hand side controls into one box. Reliability has been increased by routing cables through protected areas, rather than having them exposed at the outside. Two dual (right and left side) control boxes are supplied, one on each side of the machine. **EW**



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