GOOD VIBRATIONS?

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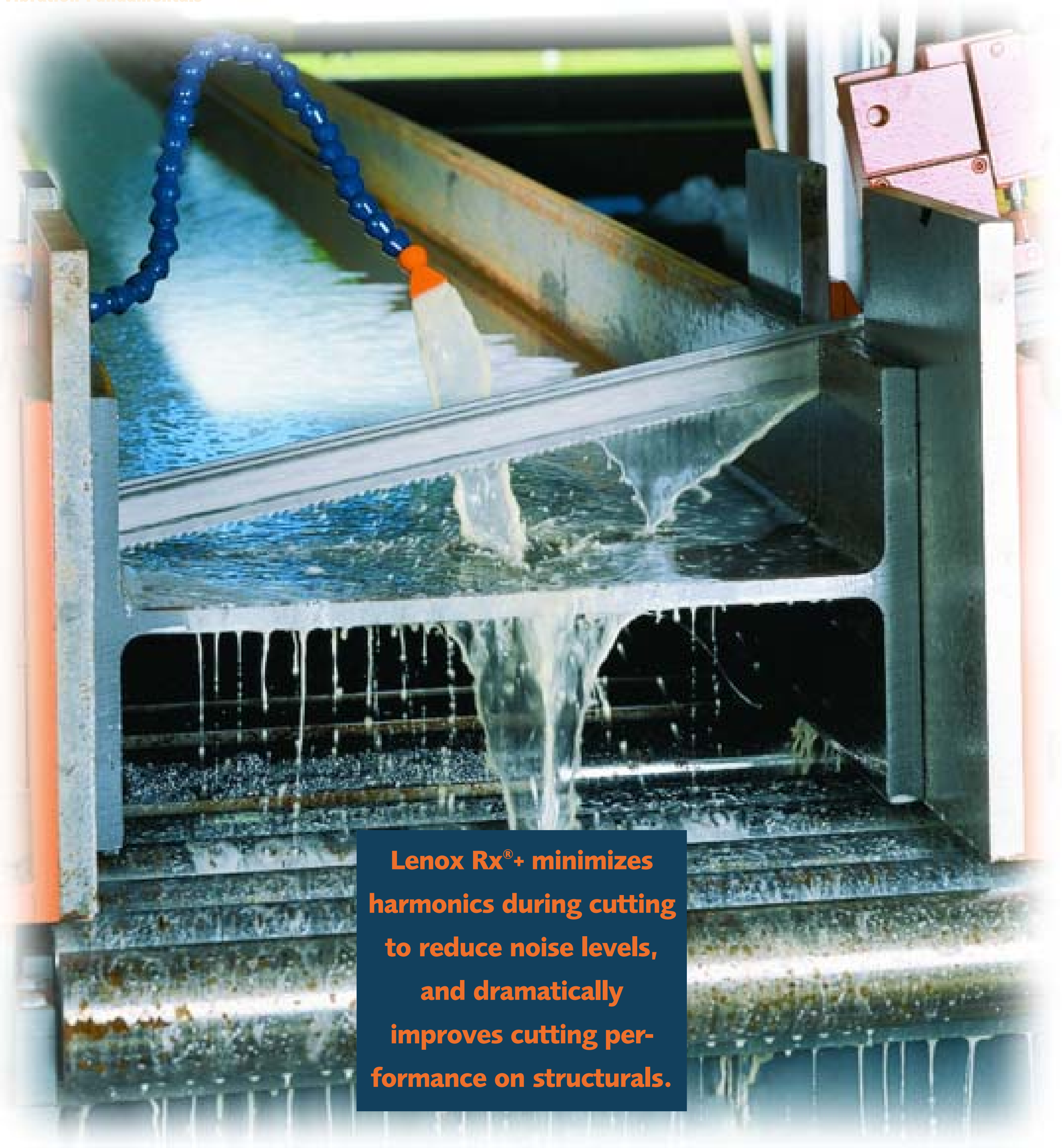
But not at the expense of reducing cutting speed, cut quality or tooth life. Excessive vibration during interrupted cuts on structural steel, tubing and nested bundles is at the heart of a variety of problems in the fabrication process. Noise from vibration can go way beyond annoying, and become an operator safety issue. Too much disturbance during the cut has a direct impact on cycle time and cost when a less than satisfactory surface finish is the result. And, instability in the process makes premature tool wear unavoidable.

Recently, engineers at American Saw took on the challenge of isolating the sources of energy and energy flow paths during the band saw cutting process, in an effort to hone in on a solution for reducing or eliminating vibration and noise. They not only identified parameters that impact the magnitude and tendency for excessive vibration, but also developed a new tooth design that minimizes harmonics during the cutting to reduce noise levels.



Lenox Rx$^{®}$+ minimizes harmonics during cutting to reduce noise levels, and dramatically improves cutting performance on structurals.

The Research

The first step in isolating the noise components of the cutting system was to develop a measuring scheme and to assemble the necessary equipment for taking measurements. In order to analyze the sources of noise, omni-directional microphones were set up in front of and behind the cut zone to identify noise frequencies. In addition, accelerometers were mounted to the horizontal carbide guides on the inlet and exit side to pick up vibration of the blade normal to the cutting direction, and on the workpiece itself to determine its contribution to the overall sound intensity levels. Experiments were done using different structural materials, blades and cutting conditions. All of the readings were collected and analyzed by a frequency spectrum analyzer. After adjustments were made to the data to ensure an accurate analysis, a "snapshot" was taken of cutting noise/vibration, and sound pressure (dBA) was plotted as a function of frequency (Hz).

Top Ten Findings

1. For any given band saw machine configuration, there is an inherent stiffness and rigidity associated with the machine and system components. While these factors are typically fixed, one critical component in affecting the overall magnitude of blade frequency vibration is proper damping of the blade through the guide system.
2. The tendency for chatter is directly proportional to the machinability of the material (typically a function of material shear strength and hardness).
3. When material cross-sections differ depending upon orientation to the blade, minimizing the length of the cut reduces the tendency for chatter.
4. Lowering band speed in combination with heavy chip loads typically has the greatest effect on reducing overall cutting noise. Unfortunately, some tooling may not be adequately designed to handle the increased cutting forces on each tooth.
5. Within the practical operating range, guide spacing and band tension do not have a significant influence on the 1000 – 1200 Hz peak frequency region.
6. Most of sound energy propagates from the lateral movement of the blade itself – not the machine or workpiece.
7. Worn blades exhibit "self-excited high frequency" chatter that can only be eliminated through resharpening of the cutting edge, if possible.
8. As set magnitude is increased, the tendency for blade instability and regenerative chatter increase.
9. Blade lateral damping mechanisms reduce noise levels.
10. Blades with highly varied tooth pitch distances and loading patterns tend to exhibit less noise and vibration.

Typically, some sawing parameters that would reduce noise level are not viable options for fabricators, due to machine, workpiece or productivity constraints. Blade parameters, on the other hand, can be designed to include features that counteract forced vibration and self-excited regenerative chatter. The engineers postulated that a blade designed for minimizing harmonics during cutting to reduce noise levels must sufficiently randomize the tooth loading patterns in both magnitude and location in order to dampen the system.

Introducing Lenox Rx$^{®}$+

Unveiled earlier this year, this specialty blade directs maximum energy into cutting structural steel and very little energy into vibration and noise. It allows for high feed rates and resists tooth strippage common to violent, interrupted cutting applications. And, it's available in extra heavy set to avoid blade pinching. Design features incorporate all that current research has to offer:

- **A resilient bi-metal M-42 tooth tip**, made of 8% cobalt high speed steel alloy with the addition of vanadium and molybdenum, which performs best in applications requiring high heat and wear resistance.
- **A unique Rx$^{®}$+ Isophonic™ tooth geometry**, highlighted by:
  - Extended pitch patterns with maximum tooth spacing variation to distribute sound energy over a broad spectrum.
  - Extended set patterns with optimized combinations of both tooth height and set magnitude variation that minimize lateral vibration, providing a system damping effect.
  - Optimized cutting channels that allow for better penetration and reduced vibration when cutting larger cross sections, such as I-beam materials.
- **An enhanced rake tooth profile**, giving the blade the tooth strength needed to power through interrupted cuts and eliminate tooth strippage. Added tooth width also provides stiffness for consistent tooth set levels and resistance to set collapse. This stable cutting edge thus decreases the tendency for regenerative self-excited chatter through the blade's break-in period. In addition, the clearance face protrusion of this design helps guide and redirect the chip off the rake face, minimizing chip welding in the tooth tip region.

Conclusion

Noise and vibration are unavoidable when cutting structural steel, I-beam, angle iron, channel iron, tubing, pipe, wide flange beams and nested bundles. Anyone who has experienced excessive noise and vibration firsthand, however, knows only too well the safety and profitability issues associated with this problem. Lenox Rx$^{®}$+ minimizes harmonics during cutting to reduce noise levels, and dramatically improves cutting performance on structurals. That means there is no sacrificing cutting speed, cut quality or tooth life to get the vibration and noise to stop!❖

Vibration Fundamentals

In traditional band saw cutting operations, where there is a great deal of energy being transmitted from the tool to the workpiece, system vibration will always be present. Understanding what's happening when vibration gets out of hand is critical to understanding how to avoid its destructive side effects. There are three types of vibration mechanisms that may come into play in the cutting process:

Forced vibration is caused primarily by the intermittent impact of each successive saw tooth entering and then leaving the workpiece. The oscillating force of the saw in turn *forces* the material being cut to vibrate at a frequency associated with the structure's natural frequency (1000-1200 Hz or cycles/second), corresponding closely to the optimal frequency for the human ear.

Self-excited high frequency chatter is determined by the workpiece itself, not the outside force. The most notable example of this type of excitation is the noise and vibration that occurs after a blade starts to wear excessively. Once a critical level is reached, the blade tends to be excited by the increased frictional rubbing of the dull tooth engaged in the structure. As the blade dulls and lateral forces increase, the blade starts to vibrate violently and exhibits chatter in the high frequency range.

Self-excited regenerative chatter refers to vibrations that feed themselves, simply as a result of the dynamics of the cut. In simplified terms, a small isolated forced vibration causes the saw blade to vibrate relative to the workpiece, causing a trailing tooth to see a larger chip load. This larger chip load creates more potential tooth deflection which leads to a progressively wavy surface. The severity of the chatter depends on how well the relative wave-like motion of the trailing teeth parallels the wavy material surface presented to these teeth.

Parallel wave patterns will result in a stable cut. Opposing wave patterns result in excessive noise, an unstable cut with variable chip thickness, and poor workpiece surface finish. Under certain conditions, as this process continues, uncontrolled and haphazard tooth loading will lead to premature tooth tip damage and, ultimately, blade failure.

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