Narrow Bandsaw Technology for Secondary Manufacturing

Narrow bandsaw technology for portable sawmills and lumber remanufacturing has proven to be economically feasible because, compared to wide bandsaws, the machines are less expensive and the costs of blades and their maintenance are much less. Narrow bands are used in applications with deep cuts that were once only possible using wide blades. There is the further benefit that narrow blades have a smaller kerf.

The downside of using narrow blades is that the feed speeds are much less than for wide blades. For portable sawmills without power-assist for handling logs, cutting speed has little effect on daily production, however slow feeds may still be a frustration for the operator. The more the material handling is power-driven, the more pressure there is to increase feed speeds. Ganging several bandmills, one after the other, is one way to get more production, but this may not work for all applications.

Wide and narrow are relative terms. In the case of bandsaws the issue is how much force the blade can hold before it buckles; the wider the blade, the greater the resistance to buckling. This concept will be explored more in the following pages, but in practical terms, "narrow" means blades up to 2 inches wide. In all other aspects, the design and operation of narrow blades are the same as for wide bands.

Much of the understanding of how to make narrow blades work comes from the metal industry. Many of the blades first used for cutting wood were designed for metal cutting, however specific tooth designs are now available for cutting wood.

This *Technology Profile* presents the factors that control saw performance, beginning with the cutting forces, so you can better understand your current sawing system and plan improvements.

Machine & Maintenance Issues

Before discussing saw design, the capability of the whole machine needs to be considered. Having a solid, well-maintained machine is critical for consistent production. A machine that does not control the wood or support the saw will force the use of thicker saws or slower feed speeds. Excellent control of the wood is needed because blades will easily break from binding.

Mechanical issues:

- wheel crossline (wheels not parallel) will twist the blade, reducing blade life
- a good guide alignment and condition ensures adequate support for the blade
- poor wheel condition (not round, worn tires) affects blade life and blade tracking
- a strain system that "sticks" and worn wheel bearings cause blade cracking.

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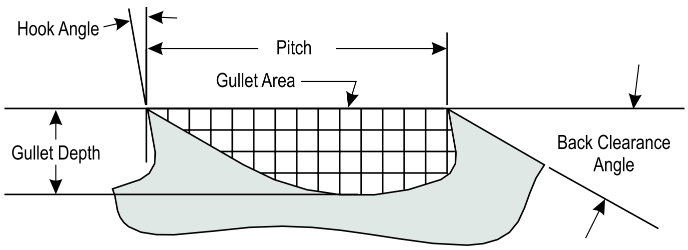
Tooth Design

Strength and gullet area requirements determine tooth shape. A deep narrow tooth will bend easily. On the other hand, if the gullet cannot hold the sawdust produced, then the sawdust will spill and heat the blade, resulting in a weaker saw and a wavy cut.

The hook angle can be reduced to increase tooth strength. For ripping, the hook is typically 10° to 15° for green softwoods, and 5° to 8° for dry softwoods and hardwoods. The back clearance angles vary from 16° for strong teeth to over 30° as in the tooth shape below. Side clearance (set) is typically 0.015" to 0.020". A larger set is needed for woods that have more "springback" or fibre tearing.



Blade Types

Carbon Steel	Least expensive, but dulls quickly because tip is only saw steel. Often cheaper to replace than sharpen. Generally spring set, but with better quality steel, the teeth can be formed by swaging.
FlexBack	Carbon blade, but tips are hardened by heat treating.
HardBack	Carbon blade with tips and back edge hardened. Used for high feed pressure. Strain needed for deep or hard cuts. Larger wheels required to avoid saw cracks if higher strain is used.
Bimetal	A strip of tool steel is welded to the tooth edge before the teeth are cut. Expensive, but stays sharp longer.
Plasma Hardened	Plain carbon blade, but skin of tip is hardened by heating with a hot gas.
Carbide or Stellite™ Tips	The most expensive blade. Used if tooth dulling is the main issue.

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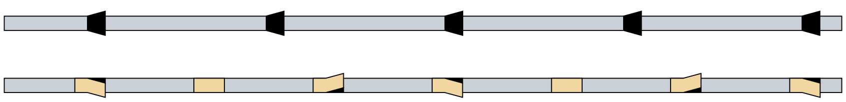
Tooth Shapes & Uses

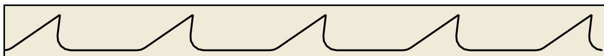
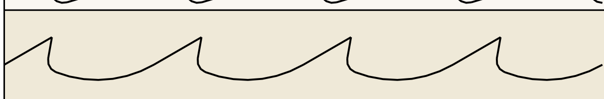
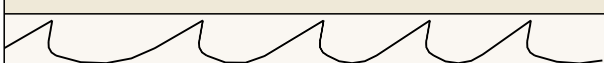
More teeth give a better finish. Fewer teeth allow faster feeds due to the larger gullet areas and less feed pressure.



Typical Specifications:

3 TPI (teeth per inch)
1.1 TPA = 7/8" pitch (note rounding)
¾ TPI = Variable pitch ranging from 3 to 4 TPA

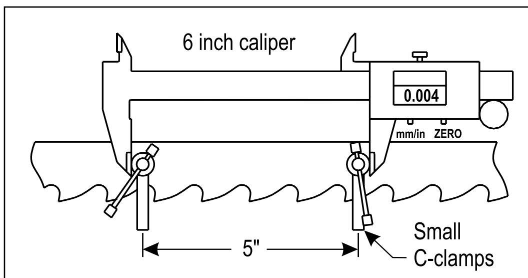
Teeth can be Spring Set, with or without a Raker Tooth, or Solid Tooth, formed by swaging or tipping with another material such as carbide or Stellite™.

	A	**Skip Tooth**	For soft, stringy woods. Large gullet area, but tooth is weak.
	B	**Triangular**	Strong shape for hardwoods.
	C	**Round Bottom**	Replacing "B" for most narrow bands due to larger gullet area, especially for softwoods. Large back angle allows better penetration of wood.
	D	**Variable**	Variable pitch (and depth) to reduce vibration.
	E	**Full Back**	A stronger tooth with either a solid tooth or spring set shape. Large gullet area. Corner at bottom of hook helps with frozen wood.

Measuring Blade Stress

Strain meters are available, but expensive. The method shown here, using calipers and two c-clamps works reasonably well.

1) Strain the blade so it is just tight.
2) Place the clamps 5" apart.
3) Measure the distance across the clamps.
4) Apply the full strain and re-measure across the clamps.

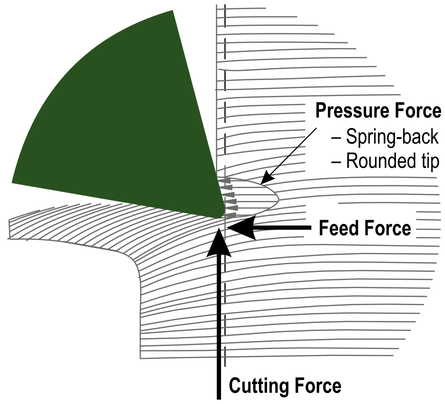


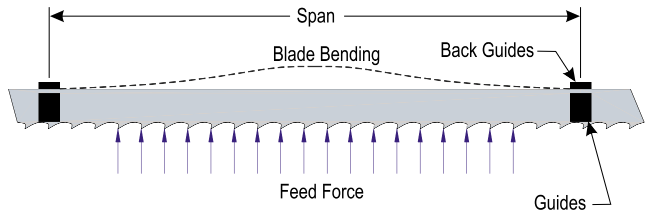
For each 0.001" the blade stretches, 6000 psi stress is applied to the blade. For the typically recommended 25000 psi, the blade should stretch about 0.004".

Cutting Forces

The two main forces on a tooth are the cutting and feed forces. The feed force, which is small compared to the cutting force, is affected by the hook angle. For a large hook angle, the feed force will reverse, pulling the saw into the wood. The hook angle can be used to "balance the saw" or neutralize the feed force.

The third force is a pressure force due to the tip being round (no tip is perfectly sharp, and dulling increases the tip radius) and fibre spring-back acting on the back of the tooth. The pressure force becomes important for small bites (slow feeds) because it stops the tip from penetrating into the wood. Keeping the saw sharp and increasing the back angle reduces the pressure force. Also, increasing the pitch reduces the total pressure force because fewer teeth are engaged.

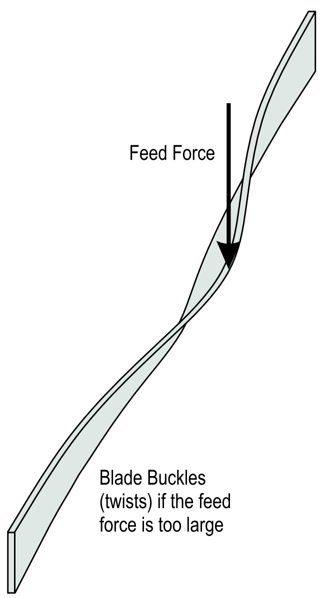




Beam Strength

The problem with narrow blades is that they buckle by twisting if the feed force gets too high. A buckled blade has no stiffness and will wander in the cut until the feed force is reduced. The ability of the blade to resist bending and buckling is referred to as Beam Strength and can be increased by increasing the strain, blade thickness or width, or by decreasing the span between the guides (back guides).

There is another aspect of beam strength: if the blade cannot push on the wood enough to overcome the pressure force, the teeth will not penetrate and the saw will not feed. For deep cuts, or a dull saw, feed pressure is needed for the teeth to penetrate, but this force may be close to, or larger than, the buckling limit – feeding harder may give penetration, but the saw will wander in the cut. The only practical remedies are to keep the guides as close to the wood as possible and to use a wider blade.



Saw Stiffness

Saw stiffness is the resistance to forces that push the saw from cutting a straight line. For narrow bands stiffness comes from the strain. Think of a narrow band as a string with some twisting stiffness. The bending resistance of the plate contributes an insignificant amount to stiffness.

Since the band is like a tight string, the strain, not the stress in pounds per square inch, controls the stiffness. A wider or thicker blade has the same stiffness if the strain is not increased. However, a wider blade can be fed harder because its beam strength (buckling resistance) is greater.

Keeping the guide as close to the wood as possible also has a significant effect on stiffness.

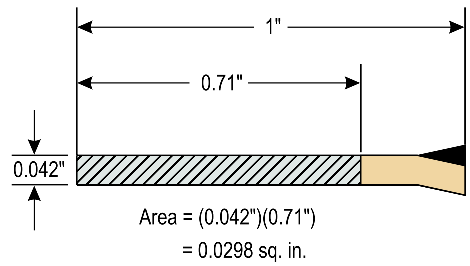
Strain

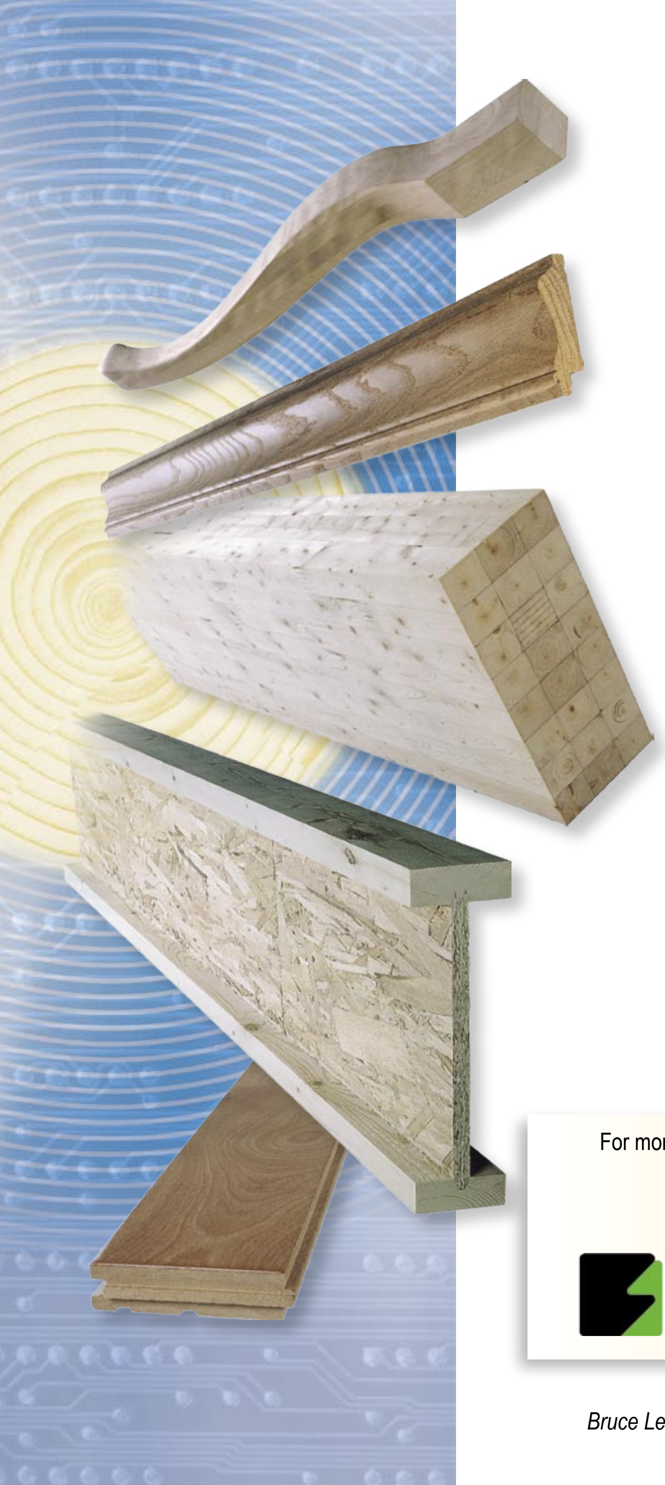
Strain is the force that pulls the wheels apart and stretches the blade. It is equal to twice the cross-sectional area of the blade multiplied by the stress in psi.

Example:

Nominal 1" blade (0.71" wide to gullet bottom)
0.042" thick
Stressed to 25000 psi

Strain = (2)(0.042)(0.71)(25000)
= 1491 lbs.





Feed Speeds

One or more of the following factors limit the feed speed:

- The bite is as large as it can be for an acceptable surface finish.
- The gullets are overloading with sawdust, resulting in heat in the saw and a wandering cut.
- Deeper depths of cut require slower feed speeds because more sawdust is produced.
- The feed force is buckling the saw, causing the blade to wander. This problem increases for deep cuts and for dull teeth. Consider increasing the tooth pitch to reduce the feed pressure.
- The cutting forces on the teeth are bending the saw, producing a wandering cut, and perhaps saw damage.

On the other hand, feeding too slowly results in rapid dulling of the teeth.

Cracking (Flex Life)

Blade cracks are caused by metal fatigue from the combined effects of the stresses from bending over the wheel, and the strain. Smaller wheels, thicker blades and higher strain all reduce saw life. Thicker blades or the use of higher strain require larger wheels.

Cracks will appear in any blade after bending over the wheels a given number of times, even if it is not cutting. This is why it is recommended to not let a blade idle for too long.

Since all blades eventually crack, the trick is to have the saw get dull first. Sharpening a saw will renew the blade life if the gullets, not just the tips, are ground to remove the micro-cracks that have formed. On the other hand, fast grinding can burn the steel or leave large burrs that cause cracks to start and grow much more quickly.

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*Ce **Profil technologique** est également disponible en français.*

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