



CLE-LINE®

***THE BRAND FOR THE PROFESSIONAL
Holemaking, Threading, Dies, Masonry, Saws***



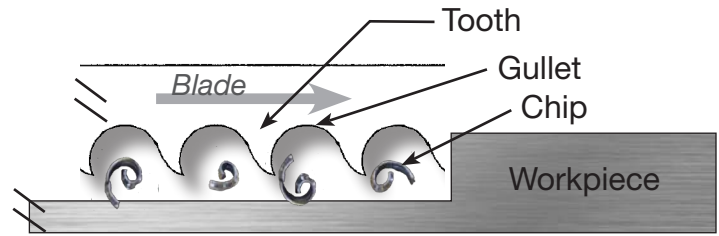
Band Saw Blade Training Manual

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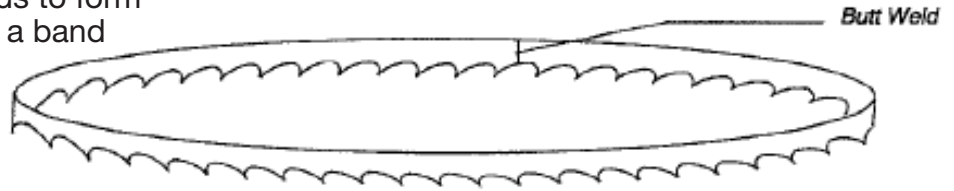
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Definition of a Band Saw Blade

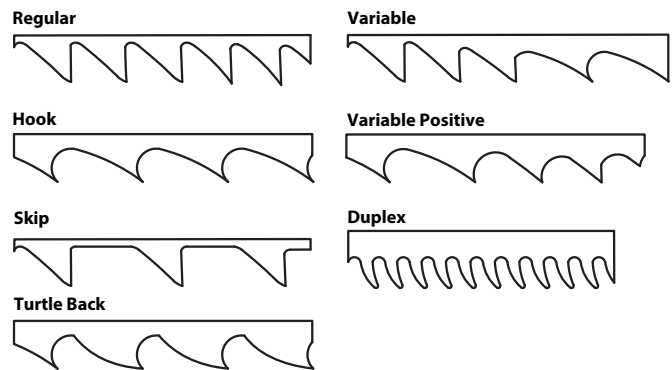
A band saw blade is a linear cutting tool consisting of hundreds of individual cutting teeth and gullets. The gullets carry coolant into the cut and carry the chips out. The cutting teeth (tips) create the chips.



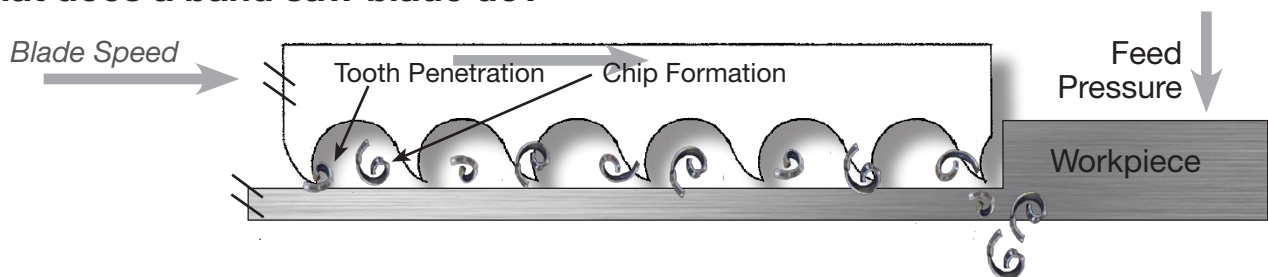
A specific length of this linear cutting tool is butt welded at the ends to form a continuous loop known as a band saw blade.



Band saw blades come in various lengths, widths, thickness, tooth pitch selections, and types.



What does a band saw blade do?



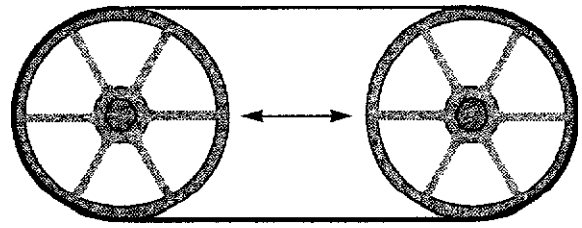
A band saw blade saws (cuts) through a wide variety of materials by removing the material in chip form. In order for the blade to do this there are three factors which must be applied: (1) feed; (2) speed, and; (3) band tension.

1. Feed: The force exerted on the blade to cause penetration of the tooth into the work piece. The harder the workpiece is the heavier the feed used.
2. Speed: The rate at which the blade travels across the workpiece. Speed creates frictional heat and wear between the cutting edge and the material being cut. The harder the workpiece, the slower the blade speed. Speed is measured in Surface Feet (or Meters) Per Minute, (SFPM).

What does a band saw blade do?

continued

3. Band Tension: The relative tightness imparted on the band after the wheel adjustment. Proper tension is critical to straight cuts and blade fatigue. It is measured by using a tension gage which is read in pounds per square inch.

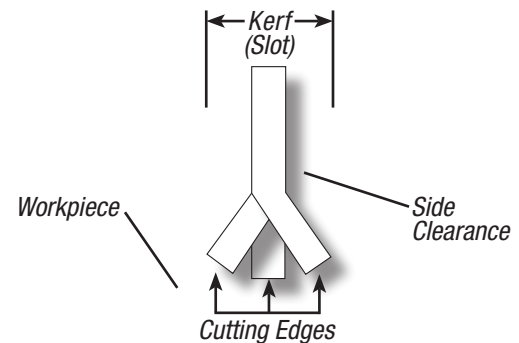


It is very important to use the right combination of speed, feed, and tension in order to obtain the recommended cutting rate of a specific material*.

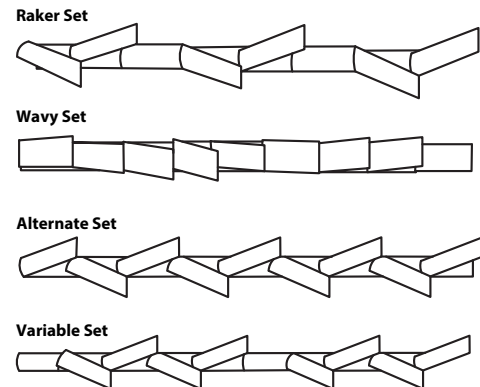
**For specific material refer to the Cle-Line® Feed and Speed Chart*

How does a band saw blade work?

The purpose of the blade is to cut or slot material. The slot which is produced by removing the material is referred to as the kerf. The kerf is created by teeth which have been set (bent) both left and right. This allows the blade to cut a path which is wider than the thickness of the band. The kerf allows the back of the band to follow through the cut without binding.





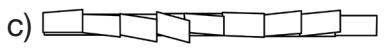
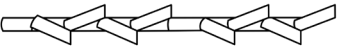
- A raker set is the standard set pattern found on constant pitch blades.
- A wavy set applies to cutting light metal such as sheet, tubing and small solid shapes.
- The alternate set is primarily used for cutting wood.
- The variable raker set is found on variable pitch blades.



Review #1

Please circle the correct answer for each question. Once you have completed the questions, turn to answer key in the back of the book.

1. A band saw blade removes material by:
 - a) Forming a chuck
 - b) Forming a chip
 - c) Creating a groove
2. The purpose of a band saw blade is to:
 - a) Cut or slot
 - b) Create a chip
 - c) Clean out a cut
3. The gullets serve to:
 - a) Reduce friction
 - b) Carry coolant into the cut
 - c) Carry the chips out
 - d) a) and c)
 - e) b) and c)
4. Feed is defined as:
 - a) The force exerted on the blade to cause penetration of the tooth into the workpiece
 - b) What you put into the band saw machine
 - c) The direction of the band saw blade
5. Speed is measured in:
 - a) Blade Revolutions Per Minute
 - b) Surface Feet Per Minute
 - c) Surface Meters Per Minute
 - d) b) and c) above
 - e) All of the above
6. Band Tension is defined as:
 - a) The downward pressure of the saw
 - b) The tightness of the blade
 - c) The play in loose band guides
7. The slot which is produced by removing material is referred to as:
 - a) The slot
 - b) The kerf
 - c) The cut

8. Which is the alternate tooth set?  
 

Machines Used for Band Saw Cutting



There are several types of band saw machines used to cut a wide variety of materials.

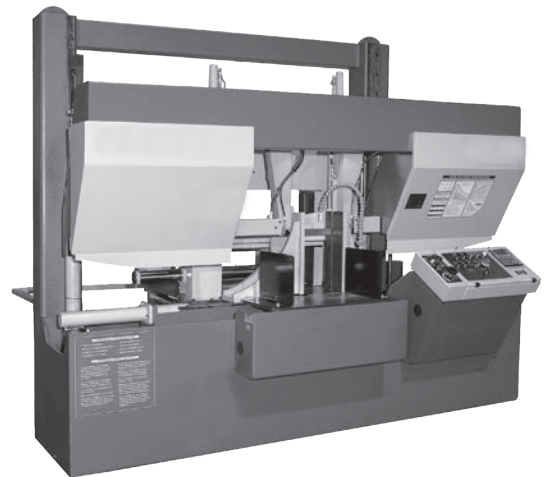
The **portable band saw** is a hand held power tool commonly found on job sites. Also commonly referred to as porta bands.

The hand held tool is used to cut conduit pipe, small channels and angles, re-bar, and a host of other materials used in the construction environment. It is generally hand fed into the workpiece with a choice of two blade speeds.

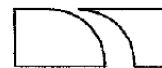
The **horizontal band saw** is generally used in production and non-production applications such as fabrication shops, steel supply houses, steel mills, and manufacturing facilities.

The **horizontal band saw** is used to cut solid material, structural steel, pipe, tubing, angles, and channels. The material is held securely in a vise while the blade is lowered into the work with hydraulic or gravity feed. Once cut, the material can be indexed automatically or manually to make the next cut.

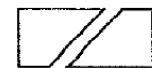
To accommodate the various materials that can be cut, the machine is equipped with blade speed control and blade feed control. This ensures that the proper cutting rates are achieved while providing optimum performance and blade life.



The **vertical band saw** is used for the same applications as the horizontal band saw. The difference is that a vertical machine allows the user to make contoured and mitered cuts.



Contoured Cut



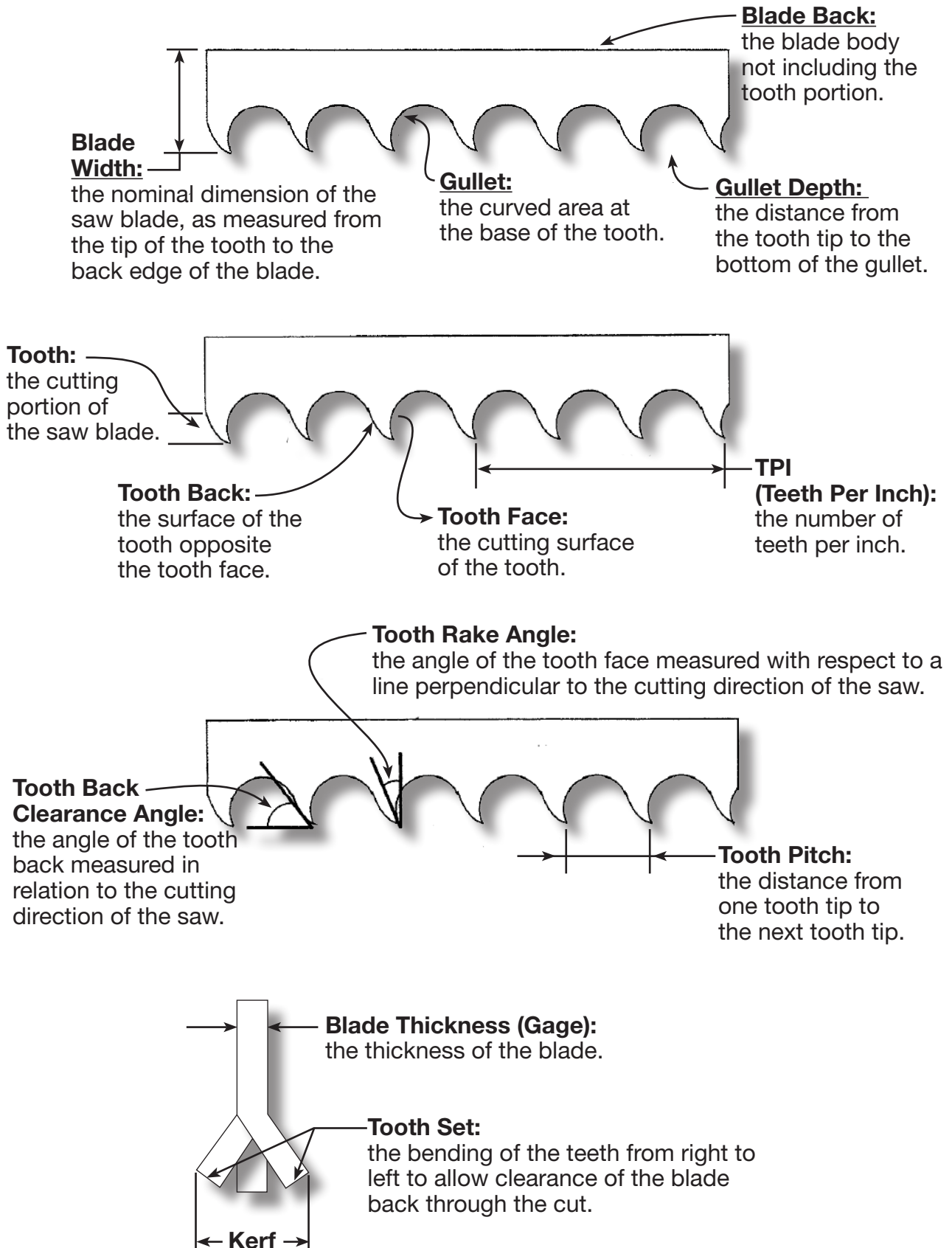
Mitered Cut

The vertical band saw is used to cut the same range of materials as the horizontal machine. Additional benefits to using the vertical machine include the option to pivot the head for mitered cuts. The machine can also make contoured cuts.

When making contoured cuts the workpiece is manually controlled for the direction of the cut and the feed pressure applied against the blade. This procedure is more common in tool and die shops as well as wood-working shops.

Parts of a Band Saw Blade

The illustrations below are of a section of a basic band saw blade. The terms defined here apply regardless of the blade type.



Review #2

Please circle the correct answer for each question. Once you have completed the questions, turn to glossary for the answer key.

1. A main difference between the horizontal and vertical band saw machines is that the vertical machine allows you to make:
 - a) Contour cuts
 - b) Deeper cuts
 - c) Mitered cuts
 - d) a) and b)
 - e) a) and c)

2. The distance from tooth tip to tooth tip on a band saw blade is called:
 - a) Thickness
 - b) Pitch
 - c) Gullet

3. The curved area at the base of the tooth is the:
 - a) Gullet
 - b) Tooth face
 - c) Tooth set

4. The tooth rake angle is measured:
 - a) From the tooth back to the direction of the cut of the saw
 - b) From the tooth face to a line perpendicular to the cutting direction of the saw
 - c) With a tooth brush

5. The tooth set is:
 - a) The bending of the teeth from right to left to allow clearance of the blade back through the cut
 - b) The opposite of the rake angle
 - c) Another word for pitch

Band Saw Blade Types

Band saw blades come in several general types. They include:

- Carbon
- Carbide Grit
- Bi-Metal
- Carbide Tipped

Each type has specific characteristics which make it more suitable in some applications than others. Each has its own composition, benefits, advantages, and preferred applications.

Carbon

Carbon blades are of one piece construction, made from high carbon steel. There are three types: flexback; hardback, and friction.

- Flexback blades feature carbon steel construction. Tooth hardness is Rc 62-66, back is softer at Rc 28-38. They have a great fatigue life at speeds up to 10,000 SFPM. Flexback blades are used in the wood industry and in non-production cutting of aluminum, copper, brass, bronze, mild steels, plastics, and fiberglass.
- Hardback blades differ from flexback in that they feature an increased back hardness from Rc 40-45. Tooth hardness is Rc 64-66. They run at speeds up to 4,000 SFPM accepting heavier feeds than flexback blades. They are used for general duty cutting and contour cutting of carbon tool steels, cast iron, and nonferrous metals.
- Friction blades are for fast cutting and high fatigue resistance. They should be operated at 8,000 SFPM to 16,000 SFPM for the fastest method of cutting ferrous metals up to $\frac{3}{4}$ " thick. They are used for cutting risers, weldments, and sheet metal. They are used on machines for friction cutting.

Bi-Metal

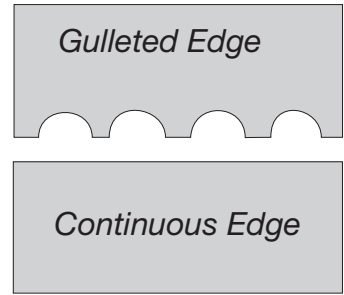
Bi-Metal blades are constructed by electron beam (EB) welding a high speed steel wire onto an alloy steel back. Bi-Metal blades offer four times more heat resistance than carbon blades. They are used for production cutting and general purpose cutting of structurals, pipe, and solids. There are two types of Bi Metal blades: Matrix II and M42.

- Matrix II H.S.S. cutting edge
 - a) Contains 8% cobalt for improved frictional heat resistance.
 - b) Tooth hardness Rc 65-68. Back hardness Rc 42-52.
 - c) Resists higher frictional heats than carbon blades with high wear resistance. Teeth are more shock resistant than M42.
- M42 H.S.S. cutting edge
 - a) Contains 8% cobalt for improved frictional heat resistance during cutting.
 - b) Tooth hardness Rc 67-70. Back hardness Rc 42-52.
 - c) For use in high and low production cutting of solids, in controlled cutting operations, and for moderate to difficult, and work hardening materials. Used for exotic materials like inconels, monels, hastalloys, titanium, and more.



Carbide Grit

- A tungsten carbide grit Rc 90 permanently bonded to an alloy steel back. Back hardness of Rc 45-47. Excellent cutting performance in tough, hard materials such as fiberglass, foamed glass, graphite composites, wire reinforced rubber, and hardened steel.
- **Gulleted edge** blades are for general cutting on materials ¼" in thickness and greater.
- **Continuous edge** blades are for materials thinner than ¼" and on hard, brittle materials which have a tendency to chip easily.



Carbide Tipped

Features & Benefits:

- Designed for aluminum castings, composite materials, rough cutting of abrasive wood and plywood
- Carbide tipped blades are designed to be fast cutting, extremely wear resistant and provide a long life
- Specially formulated submicron grade of carbide
- Triple Tooth Geometry
- Provides a smooth finish resulting in less secondary work

Applications:

Alloy Steels; Aluminum Castings; Brass; Bronze; Composites; Graphite; Hardie-board Material / Fiber Cement Composite Materials; Mold Steels; Nickel-Based Alloys; Stainless Steels; Titanium Alloys; Tool Steels; etc.

Choosing the Proper Pitch

Blade pitch is the distance from one tooth tip to the next. Blade pitches are available in constant pitch or variable pitch.

Constant pitch blades have a specific number of teeth per inch with the tooth pitch remaining equal throughout the length of the blade. The number can be 2, 3, 4, 6, 8, 10, 12, 14, 18, 24, or 32.

Variable pitch blades have pattern of various pitches and gullet depths throughout the blade. They are referred to by using a two number listing. The larger number identifies the finer pitch while the smaller number identifies the coarser pitch. This design helps reduce the harmonic noise and vibration which often contributes to a reduction in blade life. Examples of variable pitch blades include 2/3, 3/4, 4/6, 5/8, 6/10, 8/12, 10/14, 14/18, and 18/24.

When selecting pitch, there are four factors to consider:

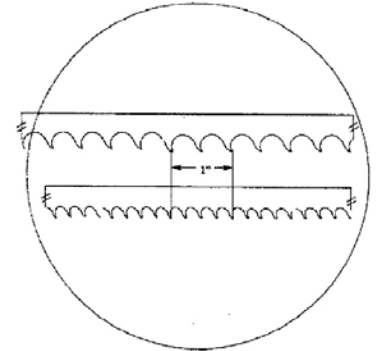
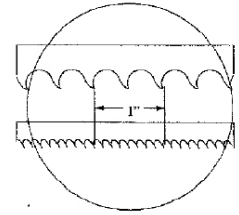
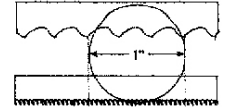
1. The coarser the pitch, the rougher the finish.
2. The coarser the pitch, the faster the cut.
3. The finer the pitch, the smoother the cut.
4. The finer the pitch, the slower the cut.



It is best to have no fewer than 3 teeth and no more than 24 teeth in your workpiece at any time.

When choosing your blade pitch, keep in mind the total size range of materials you are working with.

- For example, this one inch diameter material can be cut with pitches ranging from 3 TPI (teeth per inch) to 24 TPI and fall within the 3 teeth minimum and 24 teeth maximum rule of thumb.
- This three inch diameter material can be cut with pitches ranging from 2 TPI to 8 TPI and fall within the 3 teeth minimum and 24 teeth maximum rule of thumb.
- This six inch diameter material can be cut with pitches ranging from 2 TPI to 4 TPI.



Blade selection is based upon the combination of:

- Size range being cut
- The finish desired
- Material being cut
- Speed of cut

Choosing the Rake Angle

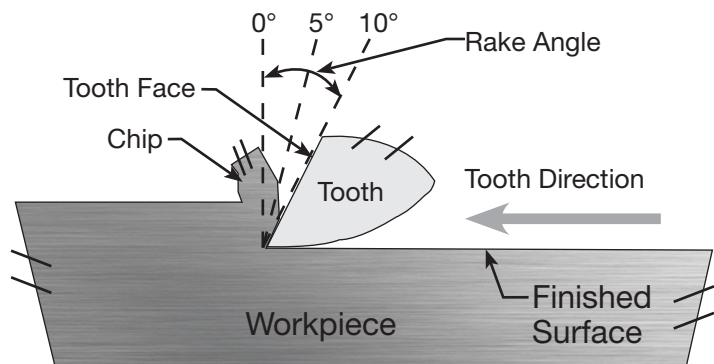
The definition of a rake angle is the angle between the face of a tooth and a line perpendicular to the surface being cut. (See the illustration below.)

If the tooth face of the blade is equal to the perpendicular line, the angle is 0° , or neutral. If the tooth face of the blade is behind the perpendicular line, it becomes positive and more aggressive in material penetration.

When using a 0° rake angle you tend to push material with the face which creates a compressive type wave in front of the tooth. When the compressed wave reaches its elastic limit it breaks away from the surface. This takes a great deal of force and puts stress on the tooth. The harder the material, the more force is required.

- Lower rake angles are generally used in the softer range of materials.
- Higher positive rake angles give the most aggressive tooth penetration for easier chip formation.

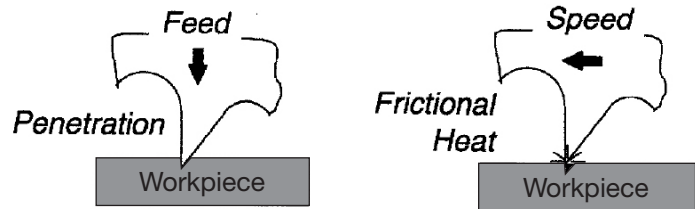
With a 5 degree to 10 degree rake angle the material is separated from the workpiece creating a chip that curls away from the tooth face. This reduces frictional heat build up in the work. The 5 degree to 10 degree rake angle is suited for tool steels, inconels, monels, stainless steels, and solids.



Understanding Speed and Feed

Speed refers to the speed at which the tooth tips of the band saw blade move with respect to the workpiece, measured in feet (or meters) per minute. Blade speed should be adjusted to the recommended range for the material being cut. Depending on the machine type, this may not always be possible because of the limitations on machine speed adjustment. Those machines that only have three or four speed variables cannot be expected to give the same desired cutting rates as those with an infinite variable. You must therefore expect a proportional reduction in the cutting rate.**

Feed refers to the force exerted on the band saw to cause penetration of the tooth into the workpiece. The lower the material hardness, the lower the feed pressure needed. As the hardness of your material increases, an increase in feed pressure is needed. Feed can be adjusted in a variety of ways: hand feed, gravity feed, and, hydraulic feed. The feed on a blade is adjusted so that a certain cutting rate can be achieved. That cutting rate is determined by the material being cut.



For more specific information, refer to the Cle-Line® and Saw Speed and Feed Chart.

*** Note that if the recommended speed falls in-between your available speed choices (due to machine limitations) go to the slower speed and adjust the feed accordingly. Using a higher speed will generate more heat at the tooth tip.*

Review #3

Please circle the correct answer or answers for each question. Once you have completed the questions, turn to glossary for the answer key.

1. Which of the blade types below is NOT a carbon blade:
 - a) Hardback
 - b) Carbide Grit
 - c) Friction
 - d) Flexback

2. Bi-metal blades are constructed by welding what to a spring steel back:
 - a) Thin strip of rebar
 - b) Special carbon alloy
 - c) High Speed Wire

3. Carbide Grit blades come in what two edges:
 - a) Bi-metal and gulleted
 - b) Flexback and gulleted
 - c) Gulleted and continuous

4. The maximum - minimum rule of blade pitch states that it is best to have no fewer than _____ teeth and no more than _____ teeth in a workpiece at any time:
 - a) 17 to 48
 - b) 6 to 20
 - c) 3 to 24

5. The rake angle of a saw blade helps to:
 - a) Penetrate the workpiece
 - b) Make the blade look pretty
 - c) Smooth out the cut

6. For a more aggressive tooth penetration and easier chip formation in hard materials, the rake angle should be:
 - a) Increased
 - b) Decreased

7. Feed refers to:
 - a) The speed at which the tooth tips of the band saw blade move with respect to the workpiece
 - b) The force exerted on the band saw to cause penetration of the tooth into the workpiece
 - c) The grain mixture given to operators at lunch time.

How to Break-in a Blade

All band saw blades should go through a break-in period to hone a stable cutting edge. In order to break-in the blade properly there are a few important steps that need to be followed.

1. Band Speed - Set for the type of material being cut. Speed is critical for the material.
2. Feed Pressure - A very important factor here is knowing what type of material is being cut. Any given material has a suggested cutting rate. This is to say that you can cut a certain number of square inches of the material per minute. Feed pressure will be reduced in order to break the blade in properly. Reducing the feed too much can result high frictional heat as the blade will simply rub the workpiece. Frictional heat can cause work hardening of the material as well as overheating of the tooth tips and premature wear. Failure to reduce the feed enough will defeat the efforts of the break-in.

a) If you are cutting softer materials such as aluminum, brass, low carbon and non-work hardening materials, reduce your feed rate by 50% for approximately 50 square inches.

*Reduce Feed
Rate 50%
for 50
Square Inches*

b) If you are cutting high carbon, tool steels, stainless steels, monels, inconels, and other high alloy steels, reduce your feed rate by 25% for approximately 25 square inches.

*Reduce Feed
Rate 25%
for 25
Square Inches*

See examples on the next page

Examples

1. Soft Material: Given a four inch round of 1018 low carbon steel, the selector chart recommends a speed of 210 - 240 SFPM and a cutting rate of 8 - 10 square inches per minute (approx. 20 - 25 square centimeters per minute.)

How many cuts will it take to break-in a new blade?

- One cut of 4" round inches is 12.56 square inches. $(4" \times 3.14 [\pi] = 12.56)$.
 $10.16 \text{ cm} \times 3.14 = \text{approx. } 32 \text{ sq. cm.}$
- Break-in requires 50 square inches of material. $50/12.56 = 3.98$ or 4 cuts.
 $127 \text{ cm} + 32 \text{ sq. cm.} = 3.96$ or 4 cuts

How long will each cut take during break-in?

- Area of material + cutting rate = Normal cutting time $12.56 + 8 = 1.57$ minutes
 $32 \text{ sq. cm.} + 20 \text{ sq. cm.} = 1.57$ minutes
- Reducing the feed rate by 50% will double the cutting time. $1.57 \text{ min.} \times 2 = \text{approx. } 3$ minutes

2. Hard Material: Given a three inch (7.62 cm.) square of 304 stainless, the selector chart recommends a speed of 90 - 120 SFPM and a cutting rate of 2 - 4 square inches (approx. 5 -10 sq. cm.) per minute.

How many cuts will it take to break-in a new blade?

- One cut of 3" square material is 9 square inches. $(3 \times 3 = 9)$
 $7.62 \text{ cm.} \times 7.62 \text{ cm} = \text{approx. } 58 \text{ sq. cm.}$
- Break-in requires 25 square inches of material. $25 \div 9 = 2.77$ or 3 cuts
 $161.3 \text{ sq cm} + 58 \text{ sq cm} = 2.78$ or 3 cuts

How long will each cut take during break-in?

- Area of material+ cutting rate= Normal cutting time $9 \div 4 = 2.25$ min (or 2 min 15 sec)
 $23 \text{ sq. cm} + 10 \text{ sq. cm.} = 2.3$
- Reducing the feed rate by 25% adds 33% to the normal cutting time. $2.25 \text{ min} \times 1.33 = \text{approx. } 3$ min for break-in.

Review #4

Please circle the correct answer or answers for each question. Once you have completed the questions, turn to the next page for the answer key.

1. In selecting the proper band for a cut, remember:
 - a) Cost of the material being cut
 - b) Type of material being cut
 - c) Size of material being cut
 - d) a) and b) above
 - e) b) and c) above

2. Blade break-in for softer materials requires the blade be run at what conditions:
 - a) Reduced feed by 25% for 25 square inches
 - b) Reduced speed by 50% for 25 square inches
 - c) Reduced feed by 50% for 50 square inches
 - d) Reduced speed by 25% for 50 square inches
 - e) None of the above

3. Blade break-in for high carbon, tool steels, and high alloy steels requires the blade be run at what conditions:
 - a) Reduced feed by 25% for 25 square inches
 - b) Reduced speed by 50% for 25 square inches
 - c) Reduced feed by 50% for 50 square inches
 - d) Reduced speed by 25% for 50 square inches
 - e) None of the above

Glossary

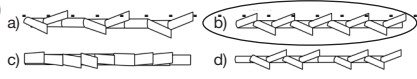
Alternate Set	A tooth set pattern on a band saw blade in which teeth are alternately set from right to left. Primarily used for wood cutting.
Band Tension	The relative tightness imparted on the band after the wheel adjustment.
Bi-Metal Blades	Blades constructed by electron beam (EB) welding a high-speed steel wire onto an alloy steel back.
Blade Back	The blade body not including the tooth portion.
Blade Pitch	The distance from one tooth tip to the next tooth tip.
Blade Thickness	The gage of the blade measured at the blade back.
Blade Width	The nominal dimension of the saw blade, as measured from the tip of the tooth to the back edge of the blade.
Break-In	The process of establishing, or honing, a stable cutting edge on a new blade.
Carbide Grit	A carbide grit blade in which a tungsten carbide grit is permanently bonded to an alloy steel back.
Carbon Blades	Blades of one piece construction made from high carbon steel.
Chips	Material that is created by the cutting teeth of a saw blade and removed from the workpiece. The process of creating and removing chips defines the cut.
Feed	The force exerted on the blade to cause penetration of the tooth into the workpiece.
Flexback	A type of carbon blade that features great fatigue life at speeds up to 10,000 SFPM.
Friction	A type of carbon blade for fast cutting and high fatigue resistance.
Gullet	The curved area at the base of the tooth that carries coolant into a cut and chips out of it.
Gullet Depth	The distance from the tooth tip to the back of the gullet.
Hardback	A type of carbon blade that features a hard back that will accept heavy feeds.
Horizontal Band Saw	A machine that uses band saw blades generally used in production and non-production applications such as fabrication shops, steel supply houses, steel mills, and manufacturing facilities.
Inconels	Hard, nickel based alloys.

Glossary *continued*

Kerf	The slot produced by removal of material from the workpiece in the cut.
M42	A type of bi-metal blade containing 8% cobalt for improved frictional heat resistance during cutting.
Matrix II	A type of bi-metal blade with teeth that are more shock resistant than M42 blades.
Modified Raker Set	A tooth set pattern on a band saw blade found in variable pitch blades.
Monels	Hard, nickel based alloys.
Portable Band Saw	A hand held machine used for band saw cutting that can be transported to a job site.
Rake Angle	The angle between the face of a tooth and a line perpendicular to the surface being cut.
Raker Set	A tooth set pattern on a band saw blade which is the standard for constant pitch blades.
Speed	The rate at which the blade travels across the workpiece.
Tooth	The cutting portion of the saw blade.
Tooth Back Clearance Angle	The angle of the tooth back measured in relation to the cutting direction of the saw.
Tooth Face	The cutting surface of the tooth.
Tooth Pitch	The distance from one tooth tip to the next tooth tip.
Tooth Set	The bending of the teeth from right to left to allow clearance of the blade back through the cut.
TPI (Teeth Per Inch)	The number of teeth per inch.
Vertical Band Saw	A machine that uses band saw blades, generally used in production and non-production applications. It is useful for making contoured and mitered cuts.
Wavy Set	A tooth set pattern on a band saw blade used for cutting light metal and small solid shapes.

Answers to the Review Questions

Review #1

- | | | | |
|--------------------------------------|------------|--|------------|
| 1. b) Forming a chip. | See page 3 | 5. d) b) and c) above | See page 3 |
| 2. a) Cut or slot | See page 4 | 6. b) The tightness of the blade. . . | See page 3 |
| 3. d) b) and c) | See page 2 | 7. b) The kerf | See page 4 |
| 4. a) The force exerted on the . . . | See page 3 | 8. c)  | See page 4 |
| blade to cause penetration of | | | |
| the tooth into the work | | | |

Review #2

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|---------------------------------------|-------------|---------------------------------------|-------------|
| 1. e) a) and c) | See page 9 | 5. a) The bending of the teeth from . | See page 13 |
| 2. b) Pitch | See page 14 | right to left to allow clearance | |
| 3. a) Gullet | See page 13 | of the blade back through the cut | |
| 4. b) From the tooth face to a line . | See page 14 | | |
| perpendicular to the cutting | | | |
| direction of the saw | | | |

Review #3

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|-------------------------------------|-------------|--------------------------------------|-------------|
| 1. b) Carbide Grit | See page 19 | 5. a) Penetrate the workpiece. . . . | See page 24 |
| 2. c) High Speed Wire. | See page 20 | 6. a) Increased | See page 24 |
| 3. c) Gulleted and continuous . . . | See page 21 | 7. b) The force exerted on the band | See page 25 |
| 4. c) 3 to 24 | See page 22 | saw to cause penetration of | |
| | | the tooth into the workpiece | |

Review #4

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|-------------------------------------|-------------|------------------------------------|-------------|
| 1. e) b) and c) above | See page 30 | 3. a) Reduced feed by 25%. | See page 30 |
| 2. c) Reduced feed by 50% | See page 30 | for 50 square inches | |



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