PREMIER
DIAMOND PRODUCTS

DIAMOND PRODUCTS TRAINING

CONTENTS

SECTION 1. WHAT IS A DIAMOND BLADE?

What is a diamond blade?
Diamond blades consist of four components:

- Diamond crystals (also known as Diamond grit or 'Diamonds')
- A bonding system (also known as a matrix)
- A segment
- Steel core.

Diamond crystals
Diamond grit used in blades are manufactured in various grit sizes and quality grades.

Bonding matrix
A metal bonding matrix holds diamond crystals in place. Metal powders such as Cobalt, Iron, Nickel, Tungsten, Bronze and other metals are used in various combinations. The bonding matrix plays several vital roles:

- Disperses and support the diamonds
- Provides controlled wear while allowing diamond protrusion
- Prevents diamond pull-out
- Acts as a heat sink
- Distributes impact and load as the diamond crystals grind the cutting surface

In the cutting process, the diamonds in the metal bond grind the material. This grinding process cuts the material and at the same time the material wears the metal bond, which exposes diamonds to the surface, refreshing the blade and extending its useful life.

Segments
The mixture of diamond crystals and bonding metal powders is hot pressed into segments. These segments are wider than the core to provide clearance during cutting.

These segments are specifically designed to wear at a rate appropriate to the aggregate being out. Diamond concentration in the segment can vary from low to very high, depending on specific requirements (e.g. lower horsepower saws generally require low concentration blades for best overall performance high horsepower saws generally require high concentration blades for best overall performance).

Steel core
The segments are attached to a premium steel alloy core.

The steel core is precision-made steel disc that has slots. The slots (also called “gullets”) provide faster cooling by allowing water or air to flow between the segments.

Most blade cores are tensioned at the factory so the blade will run straight at cutting speeds. Proper tension allows the blade to remain flexible enough to bend slightly under cutting pressure and snap back into position. An arbor hole is precisely bored into the centre.

There are three main segment welding processes for dry cutting blades. They are:-

1. Cold pressed sintering

- The quickest & most economical method
- 250 x 230mm blades can be sintered per batch
- Shorter life than a hot pressed blade because the segments are more porous
- Some bond types cannot be cold pressed

2. Hot pressed sintering

- More economical than laser welding
- Heat & pressure is increased more gradually to obtain a denser segment (or rim)
- 70 x 230mm blades can be sintered per batch
- Longer life than a cold pressed blade because the segments are more dense
- Some bond types cannot be hot pressed

3. Laser welding

- The most expensive process
- 50 x 230mm blades can be welded per hour
- The strongest welding method
- All bond types can be laser welded

The manufacturing process for sintered blades is as follows:-

- Diamond & bond powders are accurately weighed & mixed together
- The bond mix & steel core are both placed into the same mold
- Molds are loaded into the sintering equipment
- Under high heat & pressure the sintering process joins the mix & core together
- The blade is dressed (diamonds exposed)
- A percentage of each batch is safety tested (segments are stress tested)
- Product is finished (painted, etched, labelled & packed)

The manufacturing process for laser welded blades is as follows:-

- Diamond & bond powders are accurately weighed & mixed together
- The mix is placed into segment shaped molds & loaded into an isostatic press to reduce the porosity
- The segment molds are then loaded into a furnace
- Under high heat & pressure the segment becomes incredibly hard
- The segments & steel cores are loaded into the laser welding machine
- Segments are individually laser welded
- The blade is dressed (diamonds exposed)
- A percentage of each batch is safety tested (segments are stress tested)
- Product is finished (painted, etched, labelled & packed)

SECTION 2. HOW DO DIAMOND BLADES WORK?

Diamond blades don't really "cut" like a knife … they grind. During the manufacturing process, individual diamond crystals are exposed on the outside edge and sides of the diamond segments or rim. These exposed diamonds do the grinding work.

The metal bond locks each diamond in place. Trailing behind each exposed diamond is "bond tail" which helps support the diamond.

While the blade rotates on the arbor shaft of the saw, the operator pushes the blade into the material. The blade begins to cut (grind) through the material, whilst the material begins wearing away the blade (segment).

Exposed surface diamonds score the material, grinding it into a fine powder.

Embedded diamonds remain beneath the surface.

Exposed diamonds crack or fracture as they cut, breaking down into even smaller pieces. Hard, dense materials cause the diamonds to fracture even faster.

The metal bond also begins to wear, allowing new layers of diamond exposure to continue cutting.

This continuous grinding and wearing process continues until the blade is "worn out".

Sometimes a small, unusable part of the segments or rim may remain.

It is important to understand that the diamond blade and the material must work together (or interact) for the blade to cut effectively.
In order for a diamond tool to work properly, the diamond type, quality and grit size must be suited for the saw and the material. The metal matrix must also be matched to the material to be cut.

SECTION 3. HOW TO CHOOSE THE RIGHT DIAMOND BLADE

SECTION 7. **The price**

What is the most important factor for you? The initial price of the blade or the cost per cut? For smaller jobs, or occasional use, a low priced blade like our PREMIER 3 Star or PREMIER 4 Star performance levels may be preferable. For larger jobs, or regular use, a higher priced blade will actually be less expensive to use because it will deliver the lowest cost per cut. We recommend PREMIER 5 Star or PREMIER 6 Star qualities. For really big jobs, the lowest possible sawing cost per foot is usually much more important than the initial price.

2. The type of horsepower of the saw

What kind of saw or grinder is being used? What is the horsepower? What is the RPM? Masonry saw, floor saw, high speed saw, angle grinder, floor grinder? Blades should be matched with the saw and horsepower to get the best results from the blade and machine. Diamond blade manufacturers design products to run at specific speeds.

The table below describes both typical operating speeds for best performance and maximum safe speeds that should not be exceed.

Cutting Depths & Speeds

Diameter		Cutting Depth		Recommended Operating Speed	Maximum Safe Speed
Inch	**mm**	**Inch**	**mm**	**RPM***	**RPM**
4	100	1	25	9075	15000
4.5	115	1.25	30	8065	13300
5	125	1.5	40	7250	12300
7	178	2.5	65	5175	8725
8	200	3	75	5180	8730
9	230	3.25	83	4540	6640
12	300	3 5/8	100	3024	6370
14	350	4 5/8	117	2592	5460
16	400	5 5/8	143	2268	3820
18	450	6 5/8	168	2016	3365
20	500	7 5/8	194	1814	3055
24	600	9 5/8	244	1512	2500
26	660	10 5/8	270	1396	2350
30	760	11 ¾	300	1120	2040
36	910	14 ¾	375	1008	1700

Diamond blade cutting depths listed above are approximate. Actual cutting depth will vary with the exact blade diameter or saw type (or brand), or the exact diameter of the blade collars (flanges). Cutting depth will also be reduced if saw components (motor housing, blade guard) extend below the blade collars (flanges).

3. The material to be cut

Correctly identifying the material you're going to cut is the most important factor in choosing a blade. It directly affects the cutting speed and the life of the blade.

Most materials will fall into the following categories: hard, medium hard (building materials), abrasive and extremely abrasive. For example hard material would be granite or class 'A' engineering brick. Medium hard would be most concrete products & building materials. Soft would be lightweight 3 Newton block or asphalt.

When cutting hard materials, choose a softer bond. The softer bond will release the diamond grit at the point of the maximum utilization, without the danger of the bond holding the grit long enough to be over-exposed to heat at the cutting point.

If the over-exposed diamond is not released in time, the segments will overheat and it will glaze over. The glazed-over surface will stop the entire cutting / wearing process and the blade will stop cutting because there are no new diamonds being exposed at the cutting edge. The diamond blade will have to re-dressed (sharpened) before further use.

When cutting soft materials, select a harder bond that will hold the diamond grit longer so they can be more productive. If you use a soft bond to cut soft material, the bond will release the diamonds before they have reached maximum utilisation and good diamonds will be lost prematurely. The blades will still cut adequately but productivity will be poor.

Most diamond blades cut a RANGE of materials. However, the material should be matched to the blade as closely as possible. As a general rule, determine the material that will be cut most often or the material for which blade performance is most important and then select the most appropriate blade type (bond).

4. Wet or dry cutting

Choosing wet or dry cutting may be a matter of user preference or job requirement.

When using a hand tool such as an electric grinder, it is not safe to use water because of the electrical power source. For floor saws wet cutting is usually preferred because you can cut deeper when using water as a coolant. For tile and masonry saws, either wet or dry cutting can be used. For hand held petrol saws, dry blades are more popular, but they are often used wet as a form of dust control.

Wet blades MUST be used with water. Dry blades may be used either dry or wet as the job or equipment allows.

5. Variables that affect performance

Many other factors affect the blade’s performance and consequent value. Consider the diamond size, concentration and quality, the hardness of the bond, the cutting power of the saw, and how well the blade specification is matched to the material being cut. Please refer to the chart below.

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Variables that affect performance

Variables	Condition	Cutting speed	Blade life
Bond hardness	Harder	Slower	Longer
	Softer	Faster	Shorter
Diamond quality	Lower	Slower	Shorter
	Higher	Faster	Longer
Diamond Grit Size	Coarser	Faster	Longer
	Finer	Slower	Shorter
Diamond concentration	Lower	Faster	Shorter
	Higher	Slower	Longer
Horsepower	Lower	Slower	Longer
	Higher	Faster	Shorter
Blade RPM	Lower	Faster	Shorter
	Higher	Slower	Longer
Water Flow	Lower	Faster	Shorter
	Higher	Slower	Longer
Cutting Depth	Shallow	Faster	Longer
	Deep	Slower	Shorter
Material hardness	Harder	Slower	Longer
	Softer	Faster	Shorter
Aggregate Size	Larger	Slower	Shorter
	Smaller	Faster	Longer
Steel Reinforcement	Less	Faster	Longer
	More	Slower	Shorter

There are various diamond grit (mesh) sizes used in diamond blades. Let's take a closer look at their applications:-

Very fine grit

- Used when the material structure is very dense and the cut edges need to be well finished (e.g. marble & tiles)

Fine to mid-sized grit

- Used in softer bond blades for cutting harder materials & concrete
- Remember harder materials will cause the diamonds to fracture more quickly
- Higher concentration of finer grit in a soft bond increases life
- Coarse grit can give more speed, but will not always be durable in hard materials

Coarse Grit

- Used in harder bonded blades for cutting abrasive materials & asphalt
- Softer materials don't fracture the diamonds as quickly
- Coarse grit stays in the hard bond longer increasing life

SECTION 4. WHAT TO KNOW ABOUT THE MATERIAL YOU CUT

CONCRETE: When cutting concrete several factors influence your choice of diamond blade. These include

- Compressive strength
- Steel reinforcing bar
- Hardness of the aggregate
- Cured or green concrete
- Size of the aggregate
- Abrasiveness of the aggregate
- Type of sand

Age

The length of curing time after concrete is poured greatly affects the way a diamond blade will interact with it during cutting. Curing can be affected by weather (temperature, moisture and time of year) and the composition (admixtures, aggregate and sand).

Green concrete

Concrete is typically in its green state for 6 to 48 hours after it is poured. In this early state, the sand is not completely bonded with the mortar and the concrete doesn't reach full hardness. When cutting green concrete, the sand loosens more readily, and flows more freely in the slurry, and produces much more abrasion on a diamond blade.

Undercut protection is critical when cutting green concrete to prevent excessive wear on the steel core at the segment weld. Green concrete sawing is common when working on new construction projects such as; motorways, runways, driveways & industrial flooring

Cured concrete

Cured concrete is typically set at least 48 hours. The sand is completely bonded with the mortar and the concrete reaches full hardness.

Concrete slabs may vary greatly in compressive strength, measured in pounds per square inch (PSI).

Compressive strength

Concrete Hardness	PSI	Typical Application
Very hard	8,000 or more	Nuclear plants
Hard	6,000 – 8,000	Bridges, or Piers
Medium	4,000 – 6,000	Roads
Soft	3,000 or less	Pavements, Patios

Hardness of the aggregate

There are many different types of mineral used as aggregate. Hardness often varies even within the same classification of mineral. For example, granite varies in hardness.

The Mohs' scale is frequently used to measure hardness. Values of hardness are assigned from one to ten. A substance with a higher Mohs' number will physically scratch a substance with a lower Mohs' number. The Higher the Mohs' number the harder the material. The scale below shows how some common minerals fall into the Mohs' scale range.

Mohs' Range	Description	Aggregate
8-9	Very hard	Flint, sea gravel, river gravel
6-7	Hard	Hard granite, quartz
4-5	Medium hard	Medium hard granite
3-4	Medium	Dense limestone, sandstone, marble
2-3	Medium soft	Soft limestone

Aggregates

Aggregates are the granular fillers in cement that can occupy as much as 60% to 75% of the total volume. They influence the way both green and cured concrete perform. Aggregates can be naturally occurring minerals, sand and gravel, crushed stone or manufactured sand. The most desirable aggregates used in concrete are triangular or square in shape; with hard, dense, well-graded and durable properties. The average size and composition of aggregates greatly influence the cutting characteristic and selection of diamond blade.

Large aggregates tend to cause blades to cut slower, and smaller aggregates allow the blades to cut faster.

Aggregate hardness is a very important factor when cutting concrete. As hard aggregate dulls diamond grit more quickly, segment bonds generally need to be softer when cutting hard aggregate. This allows the segment to wear normally and bring new sharp diamond grit to the surface.

Softer aggregate will not fracture diamond grit as quickly, so harder segment bonds are needed to hold the diamond in place long enough to use their full potential. Most aggregates fall into the 2 to 9 range on the Mohs' scale.

Type of sand

Sand is part of the aggregate mix, and determines the abrasiveness of concrete. Sand can either be sharp (abrasive) or round (non-abrasive). To determine the sharpness of sand, you need to know where the sand is from. Crushed sand and bank sand is usually sharp (abrasive) - river sand is usually round (non-abrasive).

Steel reinforcement

Further strengthening and structural integrity of concrete is accomplished by introducing concrete reinforcing steel bars (Rebar), Steel Wire Strand or Wire meshing into the concrete. It costs more to cut concrete that contains reinforcing steel because cutting rates are slower and blade life is reduced. If the cross-sectional area of concrete is 1% steel, the blade life will be about 25% shorter than if no steel were present. Concrete with 3% can reduce blade life as much as 75%.

Asphalt

Asphalt does not cure as concrete does, and once spread and rolled, it can be cut or drilled almost immediately. Unlike cured concrete, sand in asphalt never bonds as firmly, and the slurry created when sawing will be extremely abrasive.

A metal bond similar to cutting green concrete and undercut protection for the steel core are important factors when undertaking asphalt-cutting operations.

It is common for many operators to cut through the asphalt layer into the sub-base. However, this should be discouraged as generally the sub-base contains high contents of very abrasive materials such as sand and dirt. This undesirable situation causes rapid wear of the diamond blade.

Brick and block

Generally concrete building block tends to consistently have soft, abrasive qualities while brick tends to be harder and less abrasive. There are a large variety of brick types on the market, each designed and manufactured to provide certain qualities. The degree or hardness is mostly determined by the clay mixture, method of manufacture and the firing temperature.

Stone

Natural stone comes in a variety of hardness.

Hard	Flint
	Granite
	Slate
	Marble
	Flagstone
	Sandstone
Soft	Limestone

Tile

Tile is typically on the higher range of the hardness scale although there are some differences between each type based on clay mixture, manufacturing processes and firing temperature. In recent times porcelain tiles have become widely available. Porcelain is fired at extremely high temperatures up to 1400 °C so that the body can vitrify and become non-porous. No other material is currently quite as hard as porcelain and diamond blades have had to be modified to cope with the extra hardness. A common concern when cutting tile is chipping. For this reason, diamond blades with continuous rims, closely spaced segments or turbo segments are often popular choices for cutting tiles.

SECTION 5. DRY CUTTING SAFETY GUIDELINES

DO - Insure the arrow on the blade coincides with the direction of rotation of the machine
DO - use personal safety equipment (Goggles, Gloves, Face, Head & Noise protection)
DO - Use the machine guard
DO - Insure the material is held securely before blade contact
DO - Guide the blade straight into the material without tilting
DO - Carry out a slight pendulum movement (forwards, backwards). This maximizes the true potential of blade speed and disperses heat build-up
DO - Work without too much pressure - the weight of the machine should be sufficient

DO NOT - Make long continuous cuts with a dry blade (carry out a slight pendulum movement to keep the blade cool)
DO NOT - Cut to deep in a single pass with a dry blade
DO NOT - Apply too much pressure and force your diamond blade through the cut
DO NOT - Let excessive heat be generated at the cutting edge of the blade
DO NOT - Attempt to cut curves with your blade
DO NOT - Use cutting blades for grinding or for raking out mortar joints
DO NOT - Use diamond blades on metals, wood or any other unsuitable materials

SECTION 6. WET CUTTING SAFETY GUIDELINES

DO - ensure adequate water supply to both sides of the blade.
DO - ensure that the blade cuts parallel to the wheel axis.
DO - follow the manufacturers recommended pulley size and operating speed for specific blade diameter.
DO - tighten drive belts to ensure full available power.
DO - use drive pin if fitted to the machine.
DO operate with blade guard in place and properly secured.
DO NOT - force blade or blade shaft or mount blade on undersize spindle.
DO NOT - use paper washers to pack out the clamp plates.
DO NOT - force the blade into the material. Allow the blade to cut at its own speed.
DO NOT - operate machine with damaged or open blade guard.

SECTION 7. WET DIAMOND CORE DRILLING

Diamond core drilling reinforced concrete is both an art and discipline, requiring patience, structural appreciation, a mechanical aptitude and considerable fitness.

The basics for successful core drilling are having a rigidly set up drill rig, diamond core bits with adequate clearances on the outside diameter and inside diameters, constant water flow and the right speed range and power for the bit.

Core drilling techniques
The performance of any diamond core bit depends heavily on the use of proper drilling techniques. Although drilling conditions and materials may vary, following specific guidelines ensure faster drilling speed and longer bit life.

1. Secure the core drill to the work surface so that there is no movement in the drill that would allow the bit to bind in the hole.
2. Level the drill rig by use of the base levelling screws or vacuum pump and use a small level attached to the column permanently or by a magnetic strip on the level. This procedure will ensure a perpendicular hole.
3. Use a sufficient supply of water to ensure that the segments are kept cool and the hole is constantly being flushed of abrasive cuttings.
4. Slowly lower the bit into cut so that there is no skidding or lateral movement of the drill bit.
5. Exert steady downward pressure on the bit while drilling. Do not force the bit into the material.
6. Do not stop the flow of water or the rotation of the bit as long as the bit is in the hole.
7. If the drilling rate decreases, check the core bit. The slower penetration generally means that segments are glazing and need to be redressed. It is important that the diamond segments keep their sharpness.
8. When you bit encounter steel rebar, relax pressure about 1/3 and allow the bit to cut at its own rate. Do not push the bit.
9. When drilling high PSI concrete or concrete with very hard aggregate (i.e. river gravel, flint etc) the bit will sometimes glaze over. To open or redress the core, do one of the following:
   - Reduce water flow by 1/2 and pour masonry sand into the hole until the core starts to increase speed, then gradually increase the water flow until back to original state.
   - Drill the core into a soft concrete block, soft vitrified grinding wheel or cinder block. Repeat the procedure until the diamond is open again.
10. When drilling is finished, turn the water down very low and back the core bit out of the hole with the motor running.

SECTION 8. DRY DIAMOND CORE DRILLING

The dry diamond core drill is designed to give rapid, clean service entries in brick and internal wall materials.

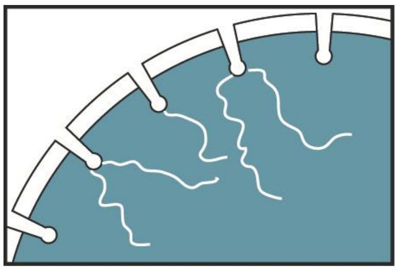
It is ideally suited for plumbers, heating and ventilating engineers, electricians, kitchen fitters and general builders.

Using an 850W, variable speed electric drill with clutch, the coring action is totally rotary enabling the operating noise and vibration to be reduced to the minimum.

1. Choose between a slotted and an unslotted dry diamond core. The unslotted cores are designed to be used with a dust extraction system. If unslotted cores are used without a dust extraction system this can have adverse effects for a dry core. Namely; Shorter segment life and the core binding (jamming) in the hole
2. Pilot drill the wall first with a 13mm (1/2”) masonry drill.
3. Locate the 12mm 'A' taper guide rod down through the core and 'push fit' the rod into the 'A' taper adaptor. Drill the hole.
4. Use an 850-watt (min) rotary drill fitted with clutch and variable speed control.
5. Don’t use hammer action when drilling with a dry diamond core drill.
6. Use machine at between 380-3000 rpm. The harder the material and larger the diameter of core, the slower the rpm. The softer the material and for smaller diameter cores, the higher the rpm. Ultimately, faster rotational speeds does not always mean better penetration.
7. Make sure the chuck is tight.
8. Clear swarf at regular intervals, as a build up will cause over heating, extensive clutch wear and a possible loss of segment.
9. Rotate core bit when entering and leaving hole.
10. Keep machine level.
11. Don’t force the bit let it do the work. This will prolong its life and reduce the chance of failure.
12. If the bit starts to vibrate, reduce pressure.

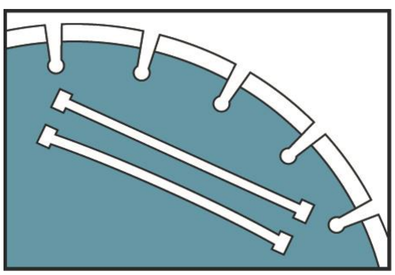
SECTION 9. FAULT DIAGNOSIS

1. CORE CRACKS



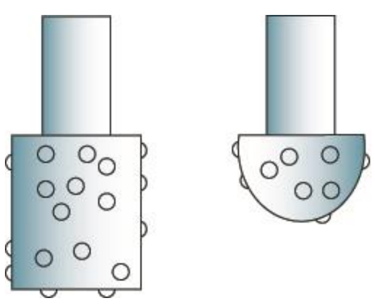
- Excessive cutting pressure or the metal bond is too hard for the material being cut causing the blade to pound in the cut. Metal fatigue will eventually cause the core to crack. Use a blade with a softer bond

2. LOSS OF TENSION



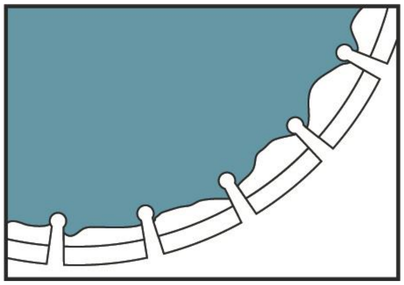
- Excessive cutting pressure or the metal bond is too hard for the material being cut causing the blade to deviate in the cut
- Check the machine is running at the correct RPM and that there is no excessive wear on the machine shaft or flanges
- Service the machine at regular intervals

3. RAPID WEAR



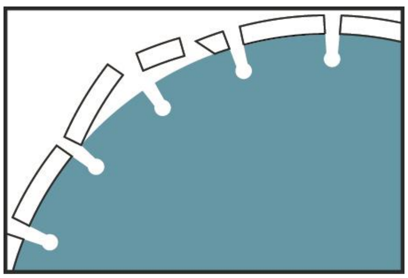
- Metal bond is too soft for the material being cut causing the diamonds to become over-exposed and releasing them prematurely before maximum utilization. Use a blade with a harder metal bond
- When wet cutting using too little water will not flush significant slurry from the cut. The extra slurry will constantly wear away at the metal bond. Increase the water feed to wash the unwanted slurry from the cut
- Blade wears out of round which can accelerate wear. This is normally due to bad bearings or a worn shaft

4. OVER HEATING



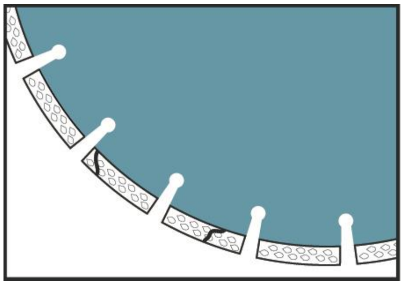
- Overheating can cause many other problems such as loss of tension, core cracks and segment loss. Overheating can be shown by black or bluish discolouration on the steel core
- Metal bond is too hard for the material being cut. Use a blade with a softer bond
- Excessive cutting pressure results in heat build-up. Allow the blade to do the work. With hand held blades, use a reciprocating (forwards, backwards) motion and avoid cutting too deep in a single pass

5. SEGMENT LOSS



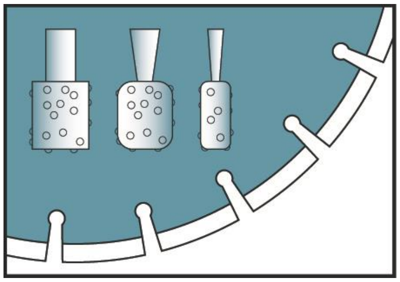
- Metal bond is too hard for the material being cut causing the blade to pound in the cut
- The material was not held firmly causing the blade to twist or jam in the cut
- The steel core has undercut due to cutting below the primary material into the sub-base

6. SEGMENT CRACKS



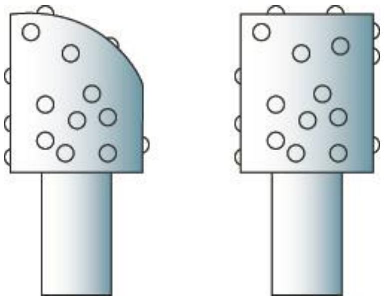
- Excessive cutting pressure or the metal bond is too hard for the material being cut causing the blade to pound in the cut. Use a blade with a softer bond

6. UNDERCUTTING



- Undercutting is the term used when the steel core wears to a knife's edge just below the segment. This can be a common problem when cutting highly abrasive materials such as asphalt.
- Ensure the blade has some type of steel core protection such as deep draft or drop segments
- When wet cutting, increase the water feed to wash the unwanted slurry from the cut
- Ensure the blade is not cutting below the primary material into the sub-base below, as constant rubbing of the loose material results in premature wear and has no beneficial effect on the cut surface

7. UNEVEN SEGMENT WEAR



- Wet cutting – Insufficient water, generally on one side of the blade. Repair blocked water pipe and ensure water is equally distributed to both sides of the blade
- Blade is worn out of round due to damaged bearing or shaft
- Segments worn on one side reducing side clearance. Check wheel alignment on floor saws and carriage alignment on masonry bench saws