Characteristics of Cutting Steels and Saw Tooth Forms

Metal cutting circular saws vary in 7 aspects:

Material • Design • Tooth Pitch • Tooth Form • Diameter • Thickness • Bore

Every one of these aspects influences the performance of the tool. Choice depends on:
(A) THE MATERIAL OF THE WORKPIECE (B) THE NATURE OF THE CUT (C) MACHINE TOOL USED.
Consideration should also be given to such ancillary conditions as lubrication, holding method, etc.

MATERIAL

Saws are manufactured from (a) carbon (tool) steels, (b) high speed steels, and (c) various carbides. The various combinations of available material are discussed under point 2 (Design).
Tool steels are cutting materials with iron as chief constituent. When carbon is added up to 1.7% they are referred to as carbon steels. The result of chemical combination between iron and carbon is iron carbide or cementite.
The hardness obtainable in a carbon steel tool depends on its carbon content. Up to 65 RC can be achieved with 1% carbon.

LOWER CARBON STEELS

(0.9-1.10%) are suitable for work where toughness and high resistance to shock are of importance.

HIGHER CARBON STEELS

(1.1-1.3%) give higher resistance to wear, and hold a keen cutting edge longer. All carbon steels fail at high temperatures, and can generally be used only for work under 205°C. However, the addition of other metals such as tungsten, molybdenum, vanadium, chromium and cobalt—with carbon content held at around 0.8%—results in steels capable of retaining their cutting properties at high temperatures. Such temperatures occurring normally with high speed work, these steels are usually referred to as High Speed Steels. Theirs is the ability to retain at elevated temperatures a high degree of hardness, known as "red hardness".
Tungsten, Molybdenum, Vanadium and Cobalt give the tool keenness of cutting edge and stability of structure at high temperatures. Chromium is responsible for high wear resistance and toughness. Carbon is the most important element in determining the hardness of high speed steels. The breakdown point—due to temperature—of HSS varies, according to the nature of the alloy, between 482°C and 593°C. The oldest alloy in this tungsten range is known as 18-4-1, the numbers referring to percentages of tungsten, chromium and vanadium respectively.

MOLYBDENUM HIGH SPEED STEELS

These are at least equal, and in many cases superior, to tungsten high speed steels, though their heat treatment is much more difficult. When hardened in free air, molybdenum produces a soft decarbonised skin of molybdenum oxide. This can of course be removed by grinding.

COBALT HIGH SPEED STEELS

Cobalt additive up to 12% results in increased hardness and red hardness of the tool. It makes the tool slightly more brittle, but it can be worked at higher speeds and is especially recommended for materials which are normally difficult to machine. Maximum advantage of cobalt steels is obtained when cutting hard materials with tensile strength over 900 N/mm².

Selected raw material specifications for GSP Precision Cutting Tools

Material	Standard No.	AISI SPEC
HSS-DM05	1.3343	M2

Super high speed steel showing satisfactory toughness with normal cutting performance. Used for the manufacture of milling cutters and metal cutting circular saw blades. For cutting materials with a tensile strength up to 900 N/mm².

EM05C05	1.3243	M35

Heavy duty cobalt steel showing satisfactory toughness and higher heat resisting characteristics. Used for the manufacture of high output cutting tools. For machining alloyed and austenitic steels with a tensile strength up to 1200 N/mm².

M42	1.3247	M42

Heavy duty cobalt steel with high wear resistance and notably higher heat resistant characteristics and satisfactory degree of toughness. Used for the manufacture of tools to cut high-tensile materials and austenitic steels with a tensile strength above 1200 N/mm².

SINTERED OR CEMENTED CARBIDES

These are a mixture of powdered tungsten carbide (sometimes with tantalum or titanium additive) with cobalt or nickel as binding material. Toughness increases with cobalt content at the expense (as in alloy steels) of hardness.
Sintered carbides are not affected by high temperatures They retain their edge at about 66 RC at temperatures surpassing 700°C. Sintered carbides used to be very expensive, and were at one time used as tips only. Their use in the solid becomes more and more accepted with the considerable reduction in price today. Cutting speeds can be increased up to twofold, with corresponding increase in tool life. But these materials remain brittle and must be used with more care.
The desirability of sintered or cemented carbides for certain operations has now been fully recognised.
The GSP programme consists of three qualities. The first two being our basic qualities.
Quality K 10/K 20 with 94% WC, 6% Co, 14.9 g/cm density, 1600 hardness on HV 30 scale, 2000 N/mm² elasticity.
This combination affords through the high tungsten content a high resistance to wear and hardness of the tool. It is best applied to work on very hard steels, short chipping materials, iron materials, light metals, titanium alloys, nickel, cobalt alloys.
Quality P 25/P 40 with 72.5% WC, 10% Co, 17.5% Tic + Tac, 12.5 g/cm density, 1450 hardness on HV 30 scale, 2200 N/mm² elasticity.
This quality gives less resistance to wear but is more tough. It is suitable for work on unalloyed steel and cast steel. It is recommended especially for work at high feeds during coarse milling, for interrupted cuts as well as for work in high temperatures.
Quality G 10 - G 60 Cobalt content between 9% and 25%.
There is an increase of elasticity with a simultaneous loss of hardness and wear resistance. "G" quality material is recommended for manufacture of knives, dies, drawing dies, punches and wear components.
As mentioned above, sintered carbide tips are generally welded on to a suitably formed base blank. Minimum width of weld base to give safe tip support is generally accepted to be about 1⁄8". With new techniques, widths of .080" or even .060" have been satisfactorily welded; but below .080" solid carbide saws are safer though more costly.

HERE, MENTION MUST BE MADE OF CHEMICAL OR PHYSICAL DEPOSITIONS OF HARDMETAL ON CUTTING EDGES. TiN AND TiCN COATING, NITRIDING, AND CHROMIUM PLATING DO INCREASE TOOL LIFE. VARIOUS COATING SYSTEMS HAVE ALSO BEEN DEVELOPED WITH TUNGSTEN AND TANTALUM CARBIDES BUT COATED TOOLS NEED TO BE CONSIDERED ON THEIR OVERALL COST EFFECTIVENESS.
WE WOULD BE ONLY TOO PLEASED TO GIVE YOU THE BENEFIT OF OUR EXPERIENCE.

DESIGN

Basically, the following variations in design are considered sufficiently standard to form part of our normal service programme:

Solid HSS Hollow ground saws, with or without keyway or pin holes. **Tipped saws** with carbide welded on to tool steel blank.

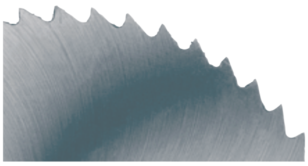
Segmental saws with 2 to 12 teeth segments rivetted on base.

Solid carbide saws Made wholly from carbide, if necessary to customer's specifications or requirements.

Circular knives and special application saws (copper cutting, etc.).

TOOTH FORM

The BSS dealing with saws is 122 PT. 1, 1953. It does not specify either the number or the form of tooth, limiting the specification to dimensions and tolerances of the saw and keyway. The SI standard (150 2296-1972) metric system, to which Britain declared its adherence, follows closely German DIN standards. These are 1837, 1838 and 1840 (tooth form). Wherever applicable the blade gives the user the benefit of the Parrot or Heller tooth:-



Conventional pointed tooth

Parrot or Heller tooth

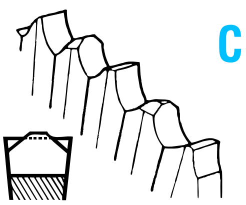
The Parrot tooth can be ground on the breast or on the top, in the former case allowing for a number of regrinds without materially reducing saw diameter. In action, the Parrot Tooth also shows considerably higher resistance to knock, and is generally used for coarse and semi-coarse pitches – very seldom in fine-pitch saws, which are usually finished with a pointed tooth.

It was stated above that the Parrot tooth increases resistance to shock. Carbide and carbide-tipped cutters are frequently designed with zero or negative rake, to increase still further the tooth angle with the same aim in view. Zero and negative rakes also permit the use of much higher speeds, and can give a very much superior finish.

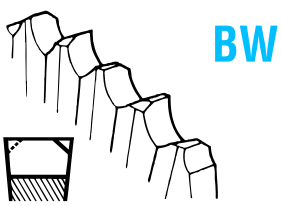
SPECIFICATIONS

All GSP cutting tools are manufactured to the relevant Standard Specification (be it BSS or ISO) wherever such specifications apply. Where no approved standard exists, as in the case of Carbide and Carbide Tipped Saws, GSP guarantee the highest possible standard according to latest engineering practice and usage.

Where saws are intended for high production, general practice allows for side relief of alternate teeth—the HZ tooth form. The geometry of the tooth (rakes, clearances, angles, etc.) depends on the nature of the material worked. Marked differences occur between HSS, solid carbide and carbide tipped saws. Segmental saws have their own geometry.



HZ tooth form, with alternate teeth relieved radially and on both sides axially.



All teeth relieved on alternate sides, for easier clearance with soft materials like bronze, copper and brass.

TOOTH PITCH

It is generally acknowledged that hard materials require fine pitch saws. In HSS metal cutting saws, the standard fine pitch is accepted to be 1/8" or 8TPI (eight teeth per inch) throughout the range of diameters. Finer pitches. e.g 1/16" or 1/32", are sometimes called for. Coarse pitches vary with saw diameter.

Carbide tipped and solid carbide saws have no officially approved standard. Our price list shows the types available. In a tipped saw the number of teeth governs the price as much as performance.

DIAMETER

Saw blanks can obviously be made in any required diameter, subject to the limitation imposed by width; there is a maximum diameter-to-width ratio which – to avoid whipping and fracture – must not be exceeded

TOLERANCES

ALL SUPER GSP SAW BLADES ARE MADE TO BE WITHIN DIN TOLERANCES. PREMIUM GSP BLADES ARE MADE TO HALF DIN TOLERANCES ON SIDE RUN-OUT AND CONCENTRICITY.

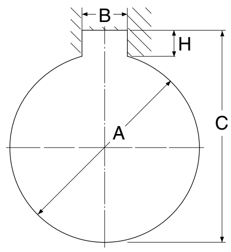
All Standard GSP Saws are manufactured and finished to the following tolerances, as specified in B.S. 122, Part 1. 1953:-

Saw Diameter	Saw Width	Bore Diameter
+.045"	+.001"	+.00075"
-.000"	-.001"	+.00025"

Closer tolerances can be quoted for on request.

KEYWAYS

Dimensions and tolerances for the more common sizes of bore are as follows:-



A Diameter of Bore, Ins.	B Width of Keyway, Ins.	C Diameter plus Height of Keyway, Ins.
	TOLERANCE	TOLERANCE
+.00075"	+.007"	+.015"
+.00025"	+.002"	-.000"
½	.094	.557
⅝	.125	.698
¾	.125	.698
1	.250	1.104
1¼	.312	1.385

Table of Weights for Cutting-Off Blades

Width	Nett weight kilos each					
mm. dia.	1.6	2	2.5	3	3.5	4
175		0.33				
200	0.38	0.48				
225	0.43	0.54				
250	0.53	0.66	0.85			
275		0.83	1.04			
300			1.23			
315			1.30	1.60		
350			1.71	2.06		
370				2.10		
400				2.30	2.90	
425				2.90	3.61	
450						4.60
500				4.28		5.71

GSP - Premium Quality Cutting-Off Saw Blades

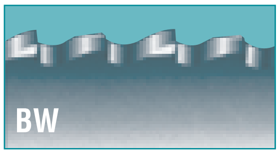
STEEL QUALITIES

SHSS/DMo5 - DIN 1.3343 - JIS SKH51 - M2
High speed TUNGSTEN MOLYBDENUM STEEL.
High performance saw blades. Hardened and tempered to 64 +/- 1˚ HRC.
Used on all types of machines to cut tubes, pipes and solid sections made out of ferrous and non-ferrous metals with tensile strengths up to 900 N/mm^2 up to 160mm cross section

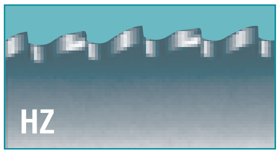
SUPER CX / EMo5Co5 - DIN 1.3243 - J1S SKH55 - M35
TUNGSTEN MOLYBDENUM COBALT bearing steel.
Special high performance saw blades. Hardened and tempered to 65 +/- 1˚ HRC.
Used mainly on Adige, Bewo and Sinico machines for cutting hard steels, titanium alloys and stainless steels with tensile strengths over 900 N/mm^2.

TOOTH FORMS FOR CUTTING-OFF SAW BLADES

B.W. With “BW” toothing. Alternate chamfered teeth; the chip is divided into two parts, 1/3rd and 2/3rd’s of the blade width respectively. Supplied as standard on saw blades with a 3mm and 4mm tooth pitch.



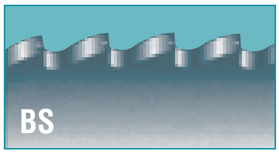
C. With HZ toothing, alternate “V and flat”. The chip is split into three parts, each 1/3rd of the blade width. This improved swarf removal permits the use of higher cutting speeds and feeds on bigger sections and solids. Supplied as standard on saw blades with 5mm and coarser tooth pitches.



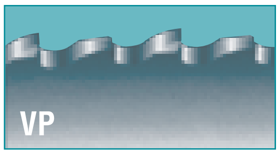
B.S. “CHIP BREAKER” TOOTHING. Chip breaker toothing is used mainly for cutting tubes. It gives a far significant improvement in performance and finish. Increased number of cutting edges engaged in the workpiece considerably reduces the side edge wear.

When used on coated saw blades, the number of cuts obtained can be outstanding.

We would be pleased to offer you the benefit of our many years of experience.



V.P. “VARIABLE PITCH” TOOTHING. Our advice on the suitability of this toothform is at your disposal.



SURFACE TREATMENT: SLIPSLIDE – STEAM-HOMO

Unless otherwise stated, all our cutting-off blades are supplied from stock with this special treatment. A controlled oxidation process produces a layer of iron oxide (Fe_3O_4) on the surface of a saw blade.

This increases its self-lubricating capability and greatly improves its resistance to “pick-up”. Slipslide is a very low cost surface treatment suitable for most general cutting work.

SLIPSLIDE

Technical characteristics
Surface Hardness: 900 HV
Coefficient of friction : 0.65

PVD Physical Vapour Deposition COATINGS.

See *Surface Coating* Section on page 33 for further details on:

TiN Titanium Nitride / **TiCN** Titanium Carbo Nitride

TiAlN Titanium Aluminium Nitride / **CRN** Chrome Nitride.

Premium Quality Cutting-Off Saw Blades

STANDARD PRODUCTION SIZES

The table on this page shows the dimensional characteristics of ***GSP*** saws: diameter, thickness, number and shape of teeth, centre hole and related driving holes.

Diameter mm	Width mm	Number of teeth and their shape – Pitch (mm) T3	T4	T5	T6	T7	T8	T9	T10	T11	T12	T14	T16
175	1.2 1.5 2.0	180BW	140BW	110HZ	90HZ		70HZ						
200	1.0 1.2 1.5 1.8 2.0 2.5	200BW	160BW	130HZ	100HZ		80HZ		64HZ				
210	2.0	210BW	160BW		110HZ		80HZ						
225	1.2 1.5 1.8 1.9 2.0 2.5	220BW	180BW	140HZ	120HZ		90HZ	80HZ					
250	1.2 1.6 2.0 2.5 3.0	250BW	200BW	160HZ	128HZ	110HZ	100HZ		80HZ		64HZ		
275	1.6 2.0 2.5 3.0	280BW	220BW	180HZ	140HZ	120HZ	110HZ		90HZ				
300	1.6 2.0 2.5 3.0	300BW	220BW	180HZ	160HZ	140HZ	120HZ		94HZ				
315	2.0 2.5 3.0 3.5	300BW	240BW	200HZ	160HZ	140HZ	120HZ		100HZ		80HZ	70HZ	
325	2.0 2.5 3.0	320BW	250BW	200HZ	170HZ		128HZ						
350	2.0 2.5 3.0 3.5	350BW	280BW	220HZ	180HZ	160HZ	140HZ	120HZ	110HZ		90HZ	80HZ	
370	2.5 3.0 3.5		280BW	220HZ	190HZ	160HZ	140HZ	120HZ	110HZ		100HZ	80HZ	70HZ
400	2.5 3.0 3.5 4.0		310BW	250HZ	200HZ		160HZ		120HZ	110HZ	100HZ		80HZ
425	2.5 3.0 3.5 4.0		320BW	260HZ	220HZ		160HZ		130HZ		110HZ		80HZ
450	3.0 3.5 4.0		350BW		230HZ		180HZ		140HZ		120HZ		90HZ
500	3.0 3.5 4.0 5.0			310HZ	260HZ		200HZ		160HZ		130HZ		100HZ
525	3.5 4.0		410BW	330HZ	270HZ		210HZ		164HZ		140HZ		104HZ
550	4.0 5.0		440BW	340HZ	280HZ		220HZ		170HZ		140HZ		
570	4.0 5.0		450BW	360HZ	300HZ		220HZ		180HZ		150HZ		
600	4.0 5.0		460BW	380HZ	320HZ		240HZ		190HZ		160HZ		

Bore	Driving Holes
Ø 32	2/8/45, 2/9/50 & 2/11/63
or Ø 32	2 slots 20/11.5 & 2 slots 15/9.5
Ø 40	2/8/55, 4/12/64 or 2/15/80
Ø 50	4/15/80 or 4/14/85
Ø 1”	1/7/16”/1⅜
Ø 1⅜”	2/19/32”/2¼

Why should you choose a CIRCULAR SAW?

Because:

- Better cut finishes
- Fewer burrs
- Lower cost per cut
- Higher cutting precision
- Available in a range of coatings
- THE TOOL CAN BE REGROUND MANY TIMES

PROBLEMS AND SOLUTIONS

Problem	Possible Causes	Solutions
Burrs	Tooth pitch too large	Reduce the pitch (see p.35)
	Worn teeth	Regrind the saw
Build-up of chip in tooth gullet	Tooth pitch too small	Increase the pitch (see p.35)
	Incorrect tooth shape	(see p.34)
	Speed too high	(see p.34)
Blade breakage	Cutting speed too high	(see p.34)
	Feed speed too high	(see p.34)
	Blade feed speed not constant	Correct
	Incorrect ratio between feed and cutting speeds	(see p.34)
	Incorrect clamping of saw blade	Check flange
	Incorrect clamping of the work piece	Check clamping system
	Tooth pitch too large or too small	Check pitch (see p.35)
	Lubrication/cooling absent or inadequate	Check the equipment
	Worn teeth	Regrind the saw
Poor surface finish of cut piece	Tooth pitch too coarse	Reduce the pitch (see p.35)
	Incorrect type of tooth	(see p.34)
	Incorrect cutting speed	(see p.34)

Premium Quality Cutting-Off Saw Blades

SURFACE COATINGS

The Platit PVD process is a new type of arc source which has been developed to overcome the limitations of traditional PVD arc technologies. This process is carried out at temperatures lower than those of tempering temperature of HSS (< 500°C).

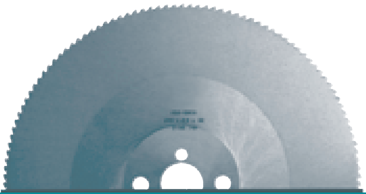
They achieve coating deposits with significantly reduced internal tensions in the saw blade and allow for higher thickness of deposit (between 3 and 5 microns).

These coatings result in:

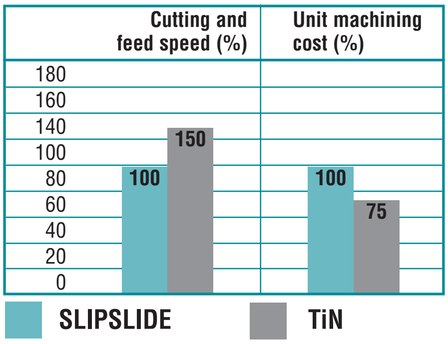
Increased surface hardness • Reduced friction • Reduced heat induction • Reduced formation of "pick up" • The possibility of dry cutting • Big improvements in productivity • Great reductions in manufacturing costs • Huge savings in the cost per cut.

TiN Titanium Nitride

Technical characteristics:
PVD coating
Surface hardness: 2200-2400 HV
Oxidation temperature: 520°C
Coefficient of friction : 0.55
Applications:
Medium hard steel
Hard steels
Furniture tube and sections in general
Mixed, steel-plastic components



TiN



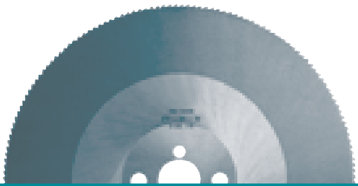
COATING BAND WIDTHS

Blade Diameter mm	Boss Diameter mm	Coated band width mm
225	90	37
250	100	40
275	100	52
300	100	50
315	100	57
325	100	62
350	120	60
370	120	70
400	120	70
425	120	73
450	130	85
500	130	95
525	130	88
550	150	100
570	150	110
600	150	115

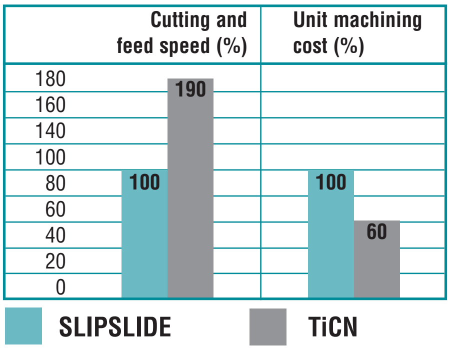
Our blades are coated to the minimum thickness point,usually two thirds of the way down the hollow ground section, thus ensuring that you can achieve the maximum depth of cut possible. It also gives you a greater number of regrinds.

TiCN Titanium Carbo Nitride

This is a multi-layer coating with a very low coefficient of friction that allows cutting with an excellent finish, avoiding “pickup” on the edge of the blade teeth, even at very high cutting speeds and feed, both on very hard steels and when cutting copper and brass alloys or extremely abrasive materials, where the phenomenon of “pickup” is particularly frequent. The great surface hardness makes it possible to work at cutting speeds 100% higher than with normal blades and also increases the number of cuts between grinding operations.
Technical characteristics:
PVD coating
Surface hardness: 3000-3300 HV
Oxidation temperature: 450°C
Coefficient of friction : 0.35
Applications:
Very hard steels - Tempered steels
Stainless steel - Titanium Aviational Alloys

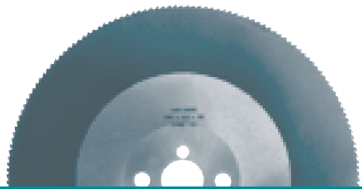


TiCN

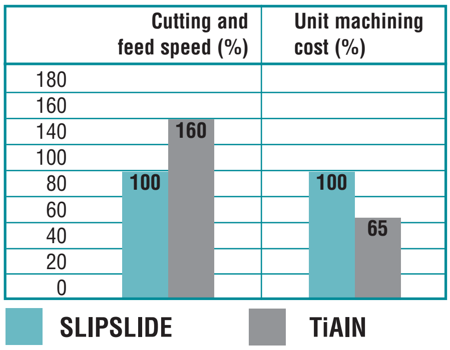


TiAIN Titanium Aluminium Nitride

Suitable for cutting materials with very high tensile strength and stainless steels; also recommended for cutting abrasive materials such as cast iron, silicon aluminium alloy, brass and copper. Particularly suited to meeting the needs of dry cutting at relatively high cutting speeds, due to its low coefficient of friction. The high temperatures it can withstand, due to its low thermal conductivity, should also be emphasised.
Technical characteristics:
PVD coating
Surface hardness: 3300-3500 HV
Oxidation temperature: 875°C
Coefficient of friction : 0.45
Applications:
Hard steels - Stainless steels - Cast iron
High cutting speeds



TiAIN



COATING SUGGESTIONS

MATERIAL TO BE CUT	SUGGESTED COATING
Mild Steels 500 – 750 N/mm²	Slipslide / TiN
Hard Steels 800 – 1000 N/mm²	Slipslide, TiCN or TiAIN
Very hard Steels, over 1000 N/mm²	Slipslide, TiCN or TiAIN
Stainless Steels	TiZN, TiAIN, TiCN
Inconel	TiAIN, TiCN
Titanium	TiZN, TiAIN
Nickel Alloys	TiCN, TiAIN
Cast-iron	TiAIN, CrN
Magnesium	TiAIN, CrN
Aluminium	Polished, CrN, TiCN
Copper	Polished, CrN, TiCN
Brass	Polished, CrN, TiCN
Bronze	CrN

Premium Quality Cutting-Off Saw Blades

TOOTHING

The technical drawing below shows the correct tooth geometry and main characteristics of the three most commonly used toothforms cutting-off blades: Toothforms (BW, C and BS).

Symbol	Description
T	Tooth pitch
p	Tooth height
h	Difference HZ
γ	Cutting angle
α	Clearance angle
f	Clearance length
B	Blade thickness
d	Gullet diameter

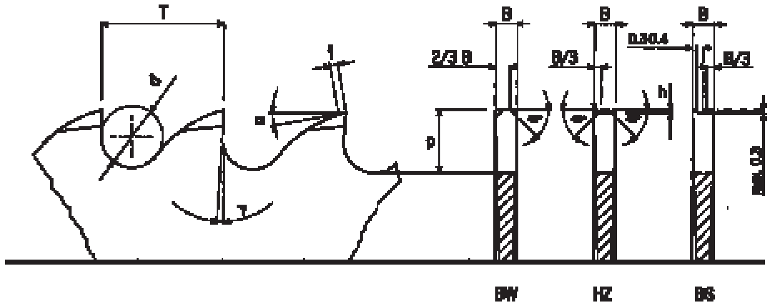


Table A shows the relationship between the pitch, height and diameter of the gullet space.

T	3	4	5	6	7	8	9	10	12	14	16
p	1,3	1,6	2,1	2,5	2,9	3,4	3,8	4,2	5,1	5,9	7,2
d	1,5	2	2,5	3	3,5	4	4,5	5	6	7	8
	h=0.2 mm					h=0.3 mm					

Table B shows the recommended cutting angle and clearance angle values for the most commonly used materials.

Materials	γ Cutting Angle	α Clearance Angle
Steel 350-900 N/mm^2	18°	12°
Steel 900-1200 N/mm^2	12°	6°
Stainless steel	12°	6°
Cast iron	12°	8°
Aluminium and its alloys	16°-22°	10°-18°
Copper	16°-20°	10°-18°
Bronze	12°	8°
Brass	15°	15°
Titanium	2°	15°

CBN Toothing

We are able to supply special toothing produced on high tech CNC machines using only borazon grinding wheels.

CBN generated toothing has a much finer ground finish, a more precise tooth geometry and the process reduces the thermal “shock” that can be caused with other types of grinding wheel during the toothing process.

Independent tests have shown that blades resharpened with CBN/BORAZON wheels can give up to 25% more cuts than blades resharpened with conventional grinding wheels.

Premium GSP saws are supplied with the following universal standard angle: Cutting angle $\gamma = 18°$, clearance angle A = 12°. These are an excellent compromise for the most common applications. For further detailed information please contact our engineering department.

CUTTING SPEEDS AND FEED RATES

It is essential that the rotation speed and feed speed (when automatic machines are involved) should be under control in order to optimise the cutting process. There is in fact a close relationship between the two speeds (rotation and feed) which must always be observed.
For example, if the blade speed is too high in relation to the speed of the speed of engagement, there is more of a "rubbing" effect than a cutting action; the blade overheats and tends to wear without performing well.
If, on the other hand, the lowering speed is too high in relation to the rotation speed, the blade does not have enough time to clear away the chip, which can cause the blade to break.
In the table below, obtained from experimental data, we recommend the most suitable Cutting speed (V) and Feed/tooth (Az) values, according to the material to be cut.

Materials	(V) Cutting Speed (m/min)	(Az) Feed/Tooth (mm)
C10, C15, St34, St37, steels up to 500 N/mm^2	30 - 50	0,03 - 0,06
C20, C40, 15Cr3, 16MnCr5, steels up to 800 N/mm^2	20 - 40	0,03 - 0,04
38NCD4, 50CrV4, 14NiCrl4, steels up to 1200 N/mm^2	15 - 25	0,02 - 0,03
Stainless steel	10 - 30	0,01 - 0,03
Cast iron	30 - 50	0,04 - 0,05
Aluminium (solid bar) and alloys	600 - 900	0,04 - 0,09
Aluminium (section) and alloys	800 - 1200	0,03 - 0,07
Bronze and Copper	200 - 300	0,04 - 0,06
Brass	400 - 600	0,04 - 0,08
Synthetic materials	60 - 150	0,04 - 0,08

GSP Premium Quality Cutting-Off Saw Blades

GUIDE TO TOOTH PITCH SELECTION AND CUTTING SPEEDS AND FEEDS

Many factors influence the choice of the right saw blades for a particular job, especially so on modern day automatic sawing machines such as Adige, Bewo, Sinico, Wagner and others where the cycle times and type of PVD coating and CBN chipbreaker toothing have such an important influence on the cutting rates and overall performance. In these cases we would be only too pleased to discuss your requirements and give you the benefits of over 50 years experience.

In general though our experience shows that the optimum cutting speed and feed has in most instances already been determined by the user to suit his local conditions.

However, where recommendations are required, we suggest the following factors are taken into account:

1. **Material to be cut**
2. **Type and cross section of material to be cut**
3. **Type of lubrication**
4. **Tooth geometry**
5. **Toothform**
6. **Type of coating on saw blade**

Following on from this, we suggest as a basis, the tooth pitches, feeds and speeds given below.

	Mild steel	Medium steel	Hard steel	Stainless steel	Cast iron	Aluminium	Bronze-Copper	Brass
Tube/Section (mm)				Pitch T (mm)				
<1	3	3	3	3	-	4	4	4
1-1,5	4	4	3	4	-	5	5	5
1,5 -2	5	4	4	5	-	6	6	6
2-3	5	5	5	5	-	7	7	7
>3	6	6	5	6	-	8	8	8
Solid Section (mm)				Pitch T (mm)				
10-20	5	5	5	5	5	6	6	8
20-40	8	6	6	6	6	8	8	10
40-60	10	10	8	8	8	12	10	12
60-90	12	12	10	11	11	16	13	14
90-110	14	14	12	14	14	18	15	17
110-130	16	16	14	16	16	20	17	19
130-150	18	16	14	16	16	20	19	20
Pitch T (mm)				Feed Speed A (mm/min)				
3	350-450	250-350	90-160	70-150	350-550	-	-	-
4	300-400	200-300	80-140	60-130	280-440	-	-	-
5	250-350	150-250	70-130	55-110	210-350	-	-	-
6	200-300	100-180	60-120	50-90	180-300	-	1400-2000	2000-4000
8	150-250	80-130	45-90	40-75	140-250	4500-8500	1000-1600	1500-3200
10	100-200	70-100	40-80	35-60	120-180	3800-6000	700-1200	1000-2500
12	80-150	65-90	35-65	30-55	90-150	3000-5000	550-850	800-1800
14	70-130	60-80	25-50	20-50	75-125	2800-4600	500-700	700-1400
16	50-120	55-70	15-40	5-35	65-110	2500-3700	400-600	600-1000
Saw dia. (mm)				(R P M)				
200	45-80	30-65	25-40	15-35	45-80	950-1500	320-480	650-950
225	45-70	30-60	20-35	15-30	45-70	850-1250	300-430	550-850
250	40-65	25-50	20-30	15-25	40-65	750-1100	250-380	500-700
275	35-60	25-45	15-30	10-25	35-60	700-1050	230-350	450-700
300	30-55	20-45	15-25	10-20	30-55	650-950	210-320	430-640
315	30-50	20-40	15-25	10-20	30-50	600-900	200-300	400-600
350	25-45	20-35	15-25	10-20	25-45	550-820	180-270	350-550
370	25-45	15-35	15-20	10-15	25-45	520-770	170-260	350-520
400	20-40	15-30	10-20	8-15	20-40	470-720	160-240	300-480
500	18-35	13-26	10-16	6-12	18-35	380-570	130-190	250-380

Cutting Performance and Life of the Tool

The most common reason for the failure of any circular saw blade is the lack of compatibility between the peripheral cutting speed applied to the blade and the nature of the material being cut.

Our experience shows that the optimum cutting speed and feed has in most instances already been determined by the user to suit his local conditions.

HOWEVER, WHERE RECOMMENDATIONS ARE REQUIRED WE SUGGEST AS A BASIS THE FOLLOWING CUTTING SPEEDS:

Material to be machined	Tensile Strength N/mm² or Hardness Brinell HB	M2 High Speed Steel: Cutting Speed metres/min.	M2 High Speed Steel: Feed per Tooth mm	Solid Carbide: Cutting Speed metres/min.	Solid Carbide: Feed per Tooth mm
Free cutting steel	350 - 500 N/mm²	10 - 45	0.02 - 0.04	80 - 180	0.01 - 0.02
General structural steel	500 - 750 N/mm²	15 - 50	0.02 - 0.03	90 - 200	0.005 - 0.02
Case hardening steel	500 - 800 N/mm²	20 - 50	0.02 - 0.03	100 - 200	0.005 - 0.02
Stainless steel, cast steel	450 - 950 N/mm²	10 - 20	0.01 - 0.02	60 - 180	0.01 - 0.02
Nitriding steel	700 - 1250 N/mm²	5 - 20	0.005 - 0.02	20 - 120	0.005 - 0.02
Cast steel	400 - 1120 N/mm²	10 - 15	0.01 - 0.02	30 - 150	0.005 - 0,02
Heat treated steel - annealed	500 - 750 N/mm²	15 - 30	0.02 - 0.03	80 - 180	0.005 - 0.02
- tempered, unalloyed	700 - 1000 N/mm²	10 - 20	0.01 - 0.02	30 - 130	0.003 - 0.01
- tempered, alloyed	700 - 1250 N/mm²	5 - 20	0.005 - 0.02	20 - 120	0.003 - 0.01
Tool steel - alloyed, tempered	900 - 1250 N/mm²	5 - 15	0.005 - 0.02	20 - 60	0.002 - 0.005
- unalloyed or alloyed					
soft annealed	HB 180 - 240	40 - 50	0.02 - 0.04	160 - 200	0.01 - 0.02
- carburised and/or					
highly alloyed, soft annealed	HB 220 - 300	40 - 45	0.02 - 0.04	160 - 180	0.01 - 0.02
Cast iron - nodular - globular	HB 100 - 320	15 - 35	0.02 - 0.05	40 - 90	0.005 - 0.02
Malleable cast iron	HB 100 - 270	15 - 45	0.02 - 0.05	40 - 100	0.005 - 0.02
Aluminium alloys	up to 250 N/mm²	120 - 1000	0.02 - 0.10	400 - 2000	0.005 - 0.1
Copper	200 - 400 N/mm²	100 - 400	0.02 - 0.08	200 - 500	0.01 - 0.03
Copper alloys	200 - 500 N/mm²	100 - 300	0.02 - 0.08	200 - 500	0.01 - 0.03
Magnesium alloys	150 - 300 N/mm²	200 - 300	0.02 - 0.05	500 - 800	0.01 - 0.03
Titanium	600 - 1100 N/mm²	15 - 50	0.01 - 0.03	60 - 100	0.005 - 0.02
Plastics - Thermo plastic non laminated	Plexiglass etc.	≤ 3000	0.01 - 0.03		
- Thermo setting plastics	Organic	≤ 3000	0.01 - 0.03	≤ 5000	0.01 - 0.10
- Laminates	Inorganic			≤ 2000	0.01 - 0.10

USE LOWER SPEED RANGES FOR:

- Rough cast and abrasive materials - Tough and harder alloys.
- Heavy, deep and large cross section cuts - Where excessive wear of saw teeth is occurring.

USE HIGHER SPEED RANGES FOR:

- Free cutting alloys - Softer alloys - Better finishes - Small diameter saws.
- Profiles, thin walled sections - Where excessive chipping of saw teeth is occurring.

FEED

In most cases local conditions are the determining factor. Generally speaking the feed is increased for soft material and large cross section cuts and reduced for hard material. Experience shows that when trying to improve performance, users normally increase the speed. However, in many instances it is better to reduce the latter and to increase the feed. This ensures higher performance (shorter cycle time) and longer life.

CORRECT CUTTING LUBRICANTS

Optimal performance and tool life cannot be achieved without sufficient cooling and lubricating. As a general rule once you have selected the cutting oil, you should increase the speed and feed until the lubricant starts to emit a slight vapour (smoke).

USEFUL FORMULAE

Cutting Speed: v [m / min]

$$v = \frac{D \cdot \pi \cdot n}{1000}$$

D = Saw dia (mm)
π = Constant 3.14
N = rpm [1/min]

Feed: S [mm / min]

$$S = S_z \cdot Z \cdot n$$

S_z = Feed per tooth (mm/tooth)
Z = Number of teeth
n = rpm [1/min]

rpm : n [1 / min]

$$n = \frac{v \cdot 1000}{D \cdot \pi}$$

v = Cutting speed (M/min)
D = Saw dia (mm)
π = Constant 3.14

Feed per tooth: S_z [mm/tooth]

$$S_z = \frac{S}{Z \cdot n}$$

S = Feed (mm/min)
Z = Number of teeth
n = rpm [1/min]