Bond Type

Products

Resin bonded wheel

The Industrial Revolution was a catalyst in the rapid and gigantic growth of the automotive and heavy machinery industries. As more and more 'difficult-to-grind' materials and alloys were being used by these industries, the demand for higher quality, effective, and durable machine tools for cutting, grinding, and machining such materials continued to escalate. As a result, superabrasive diamond and cubic boron nitride (CBN) tools were invented to meet the needs of these industries and their heavy requirements. Today, the development and use of these specialized tools has expanded to various industries as demand never ceases and new applications are being discovered.

One of the most demanded tools is the 'resin-bonded wheel', which is manufactured through the curing process of bonding diamond or CBN abrasives, with inorganic fillers, and using resins as binders, such as phenol and polyimide. Resin bonded wheels are now effectively applicable to all sorts of grinding operations such as surface grinding, cylindrical and centerless grinding, grooving and internal grinding, and etc.. It is ideally used for grinding super alloys, cermet, ceramic, glass, ferrite, high-speed steel, tool alloys, and many other new ultra-hard materials.

Resin bonded wheel

Insert grinding wheels

Circular tip saw grinding wheels

Micro tool grinding wheels

Insert top & bottom grinding wheels

Many types of resin-bonded diamond wheels are specially made for fast and cool cutting. These are particularly suited for the grinding of carbide tipped and inserted tooling, such as saws, cutters, reamers, and etc.. In addition, they are utilized in precision grinding operations on carbide dies, rolls and carbide wear parts. Resin bonds are the best choice for the precision finishing of ceramics as well as grinding tungsten carbide and ceramic thermal spray coatings. When combined with CBN, resin bonds can be used for grinding high-speed steels, tools and die steels, and superalloys with above HRC 50.

EHWA offers our customers the latest and highest quality resin-bonded wheels available today. Our extensive R&D and expertise in manufacturing diamond tools since 1975 are evident in all our products. EHWA provides complete line of resin-bonded wheels such as cylindrical grinding wheels, creep feed wheels, tip sawing grinding wheels, insert grinding wheels, and etc., and are reliable for mass-production of ground parts, wet or dry, with consistent high finish surface.

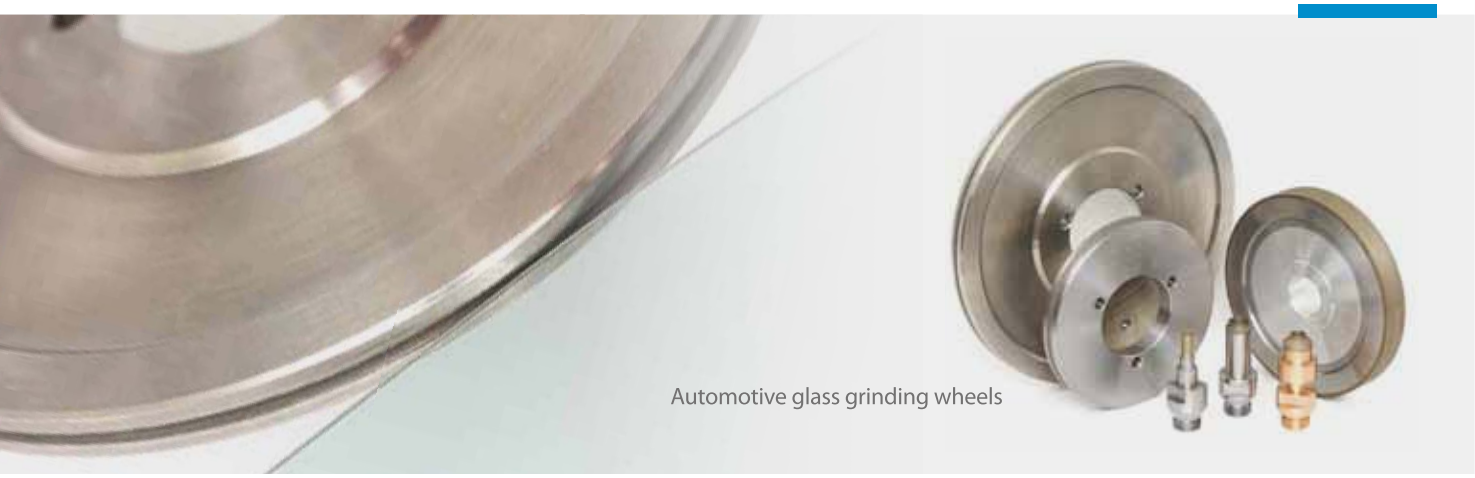
EHWA pledges to serve and satisfy the demands of our global customers with high quality and reliable products at the most competitive price, speedy delivery, and faithful warrant service.

Metal bonded wheel

The invention of glass is arguably one of the most important and useful discoveries in our history. Glass provides us with aesthetics and the ability to see beyond closed and limited space. Glass is used in every corner of the world for immeasurable applications. Life without glass would be unimaginable. The endless applications and shapes of glass products are possible by the use of special tools.

The manufacture of glass for any application is obviously a delicate process and not as easy as one may think. Special metal-bonded diamond wheels were invented to grind and shape various kinds of glass. These tools are designed to effectively and efficiently grind glass for uses such as auto-glass, architectural glass, glasses and etc.

Metal bonded wheel



Automotive glass grinding wheels

Lens grinding wheels

Honing stones

The applications of metal bonded wheels are unlimited. In addition to glass grinding, applications have extended to grinding and sharpening carbide tipped saws, ferrite, ceramic, tungsten carbide, auto-parts, quartz, stone, and etc.

In the late 1970's, EHWA started to design and manufacture edge wheels for grinding of auto-glass, and all sizes of broun tubes, from 14 inches to 33 inches. In the early 1990's, EHWA successfully began manufacturing high quality edge wheels for grinding liquid glass, which is mostly used in the semi-conductor industry. Thereafter, EHWA began producing electrolysis grinding wheels to meet the needs of the high-tech industries.

EHWA is committed to the continued development of high quality metal bonded wheels to meet the diverse needs of our valuable customers worldwide.

Vitrified bonded wheel

There is a great demand for special bonded wheels that are harder than both resin and metal bonded wheels, for the use in automated equipment and systems, which both resin and metal bonded wheels will not suffice. These highly demanded bonded wheels must be durable with extended life and be self-truing and self-dressing in order to sustain maximum performance over long periods of heavy use. Vitrified-bond technology is today's answer.

A vitrified bond is actually a ceramic bond. It is extremely hard, yet free cutting, and combines the better characteristics of both resin and metal bonds. It provides a longer tool life, effective grinding, and high productivity to provide maximum performance with minimum performance with minimum maintenance.

Vitrified bonded wheel

PCD / PCBN insert grinding wheels

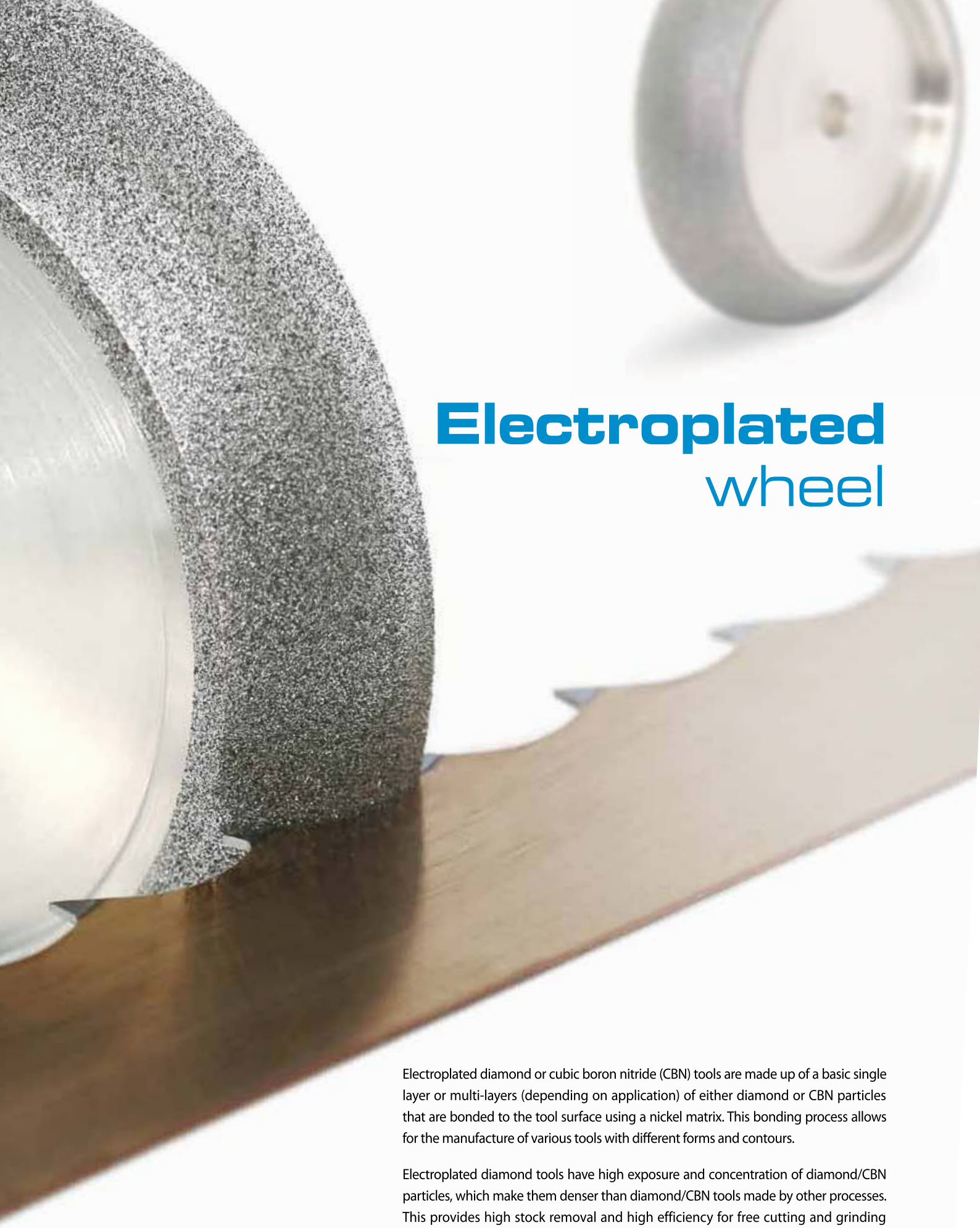
Injection nozzle bore grinding wheels

Bearing grinding wheels and honing stones

Crankshaft grinding CBN wheel

Since the late 1980's, EHWA has developed high quality vitrified-bonded CBN wheels for grinding auto-parts, such as constant velocity ball joints. Thereafter, EHWA expanded the development of vitrified-bonded wheels for many different applications such as for grinding high precision machine parts, bearings, gears, tools and dies, semi-conductors, ceramics, cermets, and in particular, cutting tools fabricated out of PCD or PCBN.

Today, the demand for vitrified-bonded wheels is sharply increasing in various high-tech industries. EHWA has put forth its best efforts to develop better quality and high-performance vitrified-bonded products to meet all diversified industrial applications.



Electroplated wheel

Electroplated diamond or cubic boron nitride (CBN) tools are made up of a basic single layer or multi-layers (depending on application) of either diamond or CBN particles that are bonded to the tool surface using a nickel matrix. This bonding process allows for the manufacture of various tools with different forms and contours.

Electroplated diamond tools have high exposure and concentration of diamond/CBN particles, which make them denser than diamond/CBN tools made by other processes. This provides high stock removal and high efficiency for free cutting and grinding materials such as non-ferrous metals, hardened steels, FRP, ceramics, and composite materials.

Electroplated wheel

Electroplated reamer

Brake pad grinding wheel

Ferrite grinding wheels

SiC mould grinding wheels

Since 1992, EHWA has manufactured all kinds of high quality electroplated tools using the latest equipment and state of the art facilities, in order to meet the growing demand for these products from various industries worldwide.

In addition to conventional nickel-plated tools, EHWA also produces state-of-the art reverse-nickel-plated diamond rotary dressers for the automotive and aerospace industries, and nickel-plated wafer dicing blades for the semi-conductor industry. EHWA will continue to engineer and develop electroplated diamond/CBN tools for our valuable customers worldwide.

Rotary dresser

High precision diamond tools are the most effective and practical means for most high-tech industries in the modern world to manufacture high precision machine parts, products, and other equipment. The automotive, aerospace, and turbine industries require extremely high precision machining and grinding tools, especially for application with new and advanced hard materials.

Rotary dresser

For water pump & ball bearings

For gear

For injection needle

For turbocharger

A diamond rotary dresser is a state-of the-art diamond tool that enables mass production of extremely high precision products, such as engine and turbine parts for the automotive and aerospace industries, at very competitive production costs.

Since 1990, EHWA has been able to meet the demand of rotary dressers by aggressively investing millions of dollars and recruiting top engineers for the R&D and manufacturing rotary dressers. In 1992, EHWA successfully completed development and began supplying rotary dresser for the automotive and aerospace industries. EHWA Diamond Rotary Dressers are engineered to quickly and accurately, dress specific forms into aluminum oxide and silicon carbide grinding wheels for extremely high precision grinding. EHWA Diamond Rotary Dressers are also ideal for dressing conventional abrasive wheels of specific profiles for grinding bearings, screws, and gears.

EHWA assures our global customers that we manufacture only the highest quality rotary dressers that are able to meet the highest expectations and requirements of applicable use in any industry.

Stationary dresser

The importance of dressing and truing abrasive grinding wheels can never be over-emphasized. Dressing will restore the exposure and cutting ability of the abrasives on the wheel surface. Dressing must be performed after truing or whenever the wheel surface becomes loaded or glazed, or loses its cutting ability. Dressing removes the unwanted residue, such as braze and steel particles, from the wheel surface. Dressing also removes small portions of the bond material and exposes the abrasives, thus allowing for effective cutting action. Truing is the procedure for eliminating any unwanted 'run-out' once the wheel has been mounted. Truing is best done wet.

In general, there are four types of dressers 1) single point diamond dressers 2) multi-point diamond dressers 3) forming diamond dressers and 4) impregnated diamond dressers.

Stationary dresser

SDD
Single-point Diamond Dressers

MDD
Multi-point Diamond Dressers

FDD
Forming Diamond Dressers

IDD
Impregnated Diamond Dressers

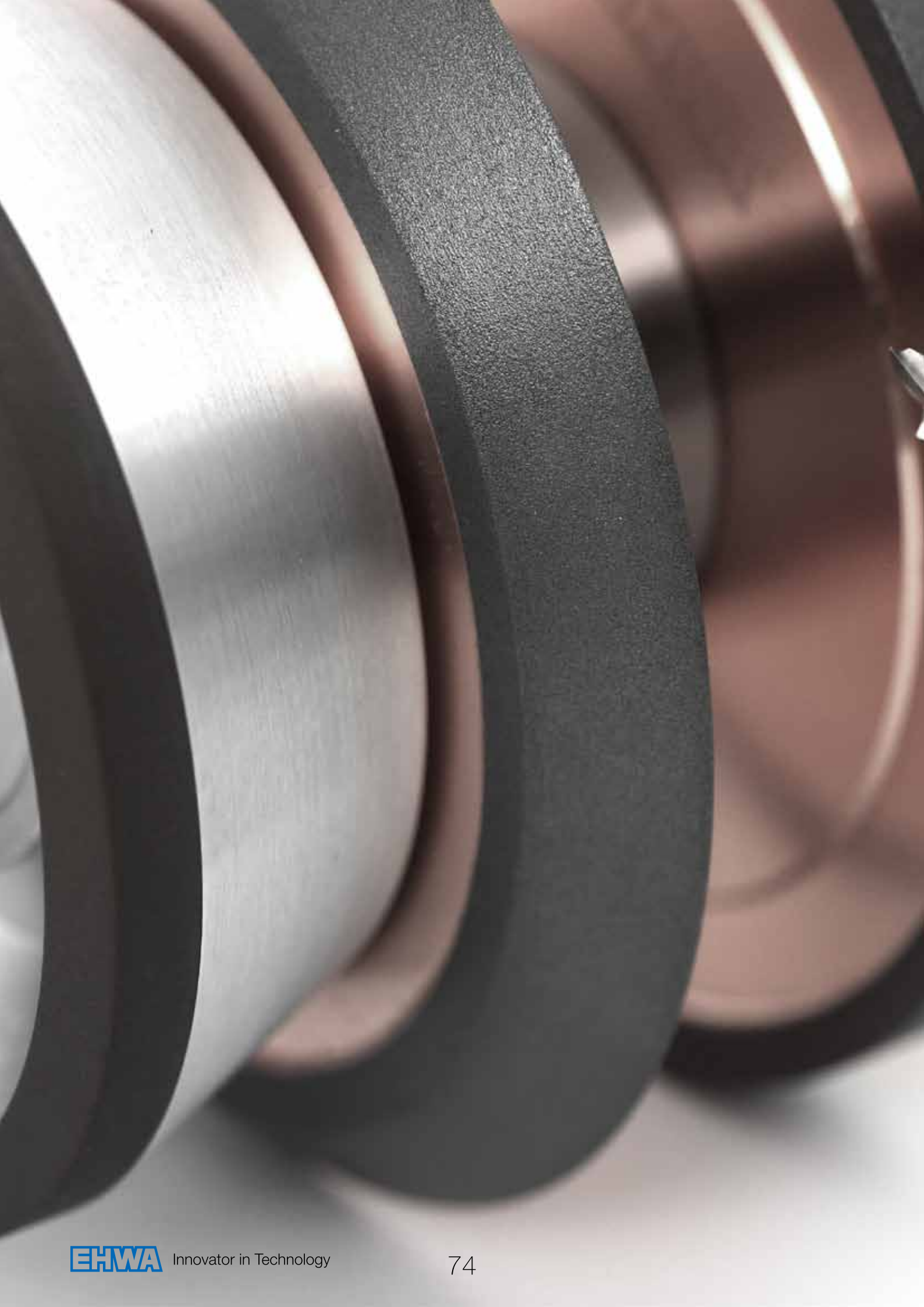
1. SDD (Single-point Diamond Dressers)
This type of dresser is made by sintering a selected diamond crystal with a metal matrix in a steel shank. The point of the set diamond is concentric with the shank

2. MDD (Multi-point Diamond Dressers)
This type of dresser is made by sintering two or more diamonds with a metal matrix to provide multi-diamond points for dressing larger and wider abrasive wheels. There are many advantages for multi-point diamond dressers. The multi-points allow the spreading of resistance, thus reducing frictional heat, extending tool life, reducing likelihood of early failure, and allowing for faster dressing.

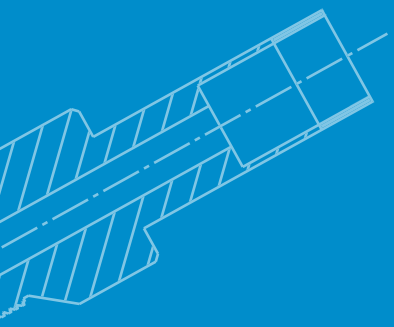
3. FDD (Forming Diamond Dressers)
This type of dresser is made by sintering a high quality mono-diamond crystal with a metal matrix in a steel shank, and then grinding into various shapes such as a conical point with radius, facet, or profile.

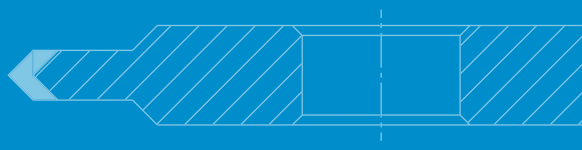
4. IDD (Impregnated Diamond Dressers)
This type of dresser is made by sintering a mixture of selected diamond particles with a metal matrix. This provides a longer tool life, is very economical, and is ideal for use with larger and wider abrasive wheels.

EHWA is committed to developing all kinds of diamond dressers by applying up-to-date technology for supporting our customers around the world.

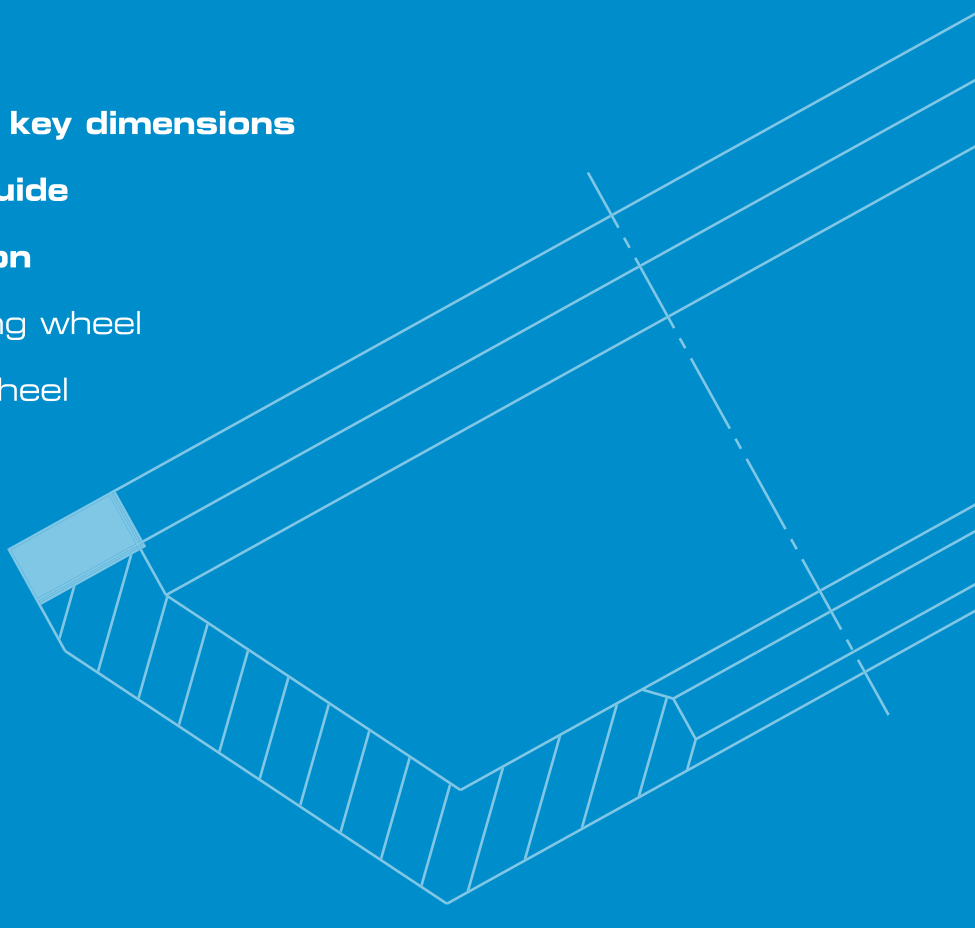


Superabrasive grinding wheels





Contents



How to order
diamond and CBN wheels

When placing your orders, please provide us with the following information.

1. **Shape**
2. **Dimension**

Provide the shape and dimensions in detail. If possible, include a drawing.

3. **Abrasive**
4. **Grit size**
5. **Grade**
6. **Concentration**
5. **Bond**
8. **Quantity**

In order to handle your order properly, we also like to be informed of the following

9. **Work**

A) Material (type & quality)
B) Shape
C) Dimension and dimensional tolerance (precision)
D) Hardness
E) Grinding removal or depth of cut
F) Required surface roughness (Rmax, Ra, Rz)

10. **Machine used**

A) Type B) Horse power

11. **Grinding condition**

A) Wheel speed: r. p. m.
B) Infeed : u. mm
C) Table speed : m/min
D) Cross feed : mm
E) Coolant : (dry or wet, coolant type)

EHWA standard

Markings for diamond and CBN wheels
Resinoid & vitrified bond

Abrasive	Grit size (mesh)	Grade	Concentration	Bond	Bond modification	Filler	Porosity
Diamond	**Normal**				**Resinoid**		
D	60	J Soft	25 1.1ct/cc	B Resinoid	BA	1.5	
ND	80	N Medium	50 2.2ct/cc	V Vitrified	BB	2	
DM	100	R Hard	75 3.3ct/cc		BC	3	
CSD	120		100 4.4ct/cc		BCT	4	
	140		125 5.5ct/cc		BD	5	
	170		150 6.6ct/cc		BE	6	
	200		175 7.7ct/cc		BG	7	
	230		200 8.8ct/cc		BH	8	
	270				BP	10	
	325				BQ		
	400				BX		
					BXT		
CBN	**Micron**				BXC		
B	40/60				PAE		
NB	40/50				PA8		
BM	30/40				BMX		
NBM	22/36						
	20/30				**Vitrified**		
	15/25				VB	W	B
	8/16				VBT	M	F
	6/12				VE	G	P
	4/8				VA	A	U
	3/6				VD	N	Y
	2/4				VCL	V	I
	0/2				VH	Z	C

EHWA standard

Markings for diamond and CBN wheels
Metal bond

Abrasive	Grit size (mesh)	Grade	Concentration	Bond	Bond modification

Diamond
SD
SDC
SDM

Normal
20
30
40
50
60
80
100
120
140
170
200
230
270
325
400

G, H, I	Very soft
J, K, L, M	Soft
N	Normal
P, Q, R	Hard

25	1.1ct/cc
50	2.2ct/cc
75	3.3ct/cc
100	4.4ct/cc
125	5.5ct/cc
150	6.6ct/cc

M	Metal

MB21
MC9
MA
MF
MP1
ME4
MG7
MG21N
MX32
MX4
MFS
MX56
MX57

CBN
CBN
CBS
CBM

Micron
40/60
30/40
22/36
15/25
10/20
8/16

Diamond and CBN types

Resinoid & vitrified bond

Diamond

D	Non-coated type. Friable, irregular shape. General grinding of cemented carbide. Resinoid and Vitrified bond. Mainly used in wet grinding. Grit size: #60 - #3000
ND	Nickel-coated type. Good bondability. Used primarily for grinding of all kinds of workpieces (cemented carbide, ceramic, cermet, glass, ferrite, etc.). Resinoid bond. Wet and dry grinding. Grit size : #60 - #400
DM	Micron type. Friable, regular shape. Used in lapping and polishing (cemented carbide, ceramic, glass ,etc.). Resinoid and Vitrified bond. Only used in wet grinding. Grit size : micron D 40/60 - D 0/2
CSD	Nickel-coated type. High strength, excellent bondability. Used in cemented carbide and hardened steel combinations grinding. Grit size : #60 - #400 Grit size : micron D 40/60 - D 20/30

CBN

B	Non-coated type. Used in general grinding (bearing, cam shaft, roll, dies, etc.). Vitrified bond. Only used in wet grinding. Grit size : #60 - #325
NB	Nickel-coated type. Good bondability. Used primarily for grinding of hardened steel (HSS, SKD-11, SUS, etc.). Resinoid bond. Wet and dry grinding. Grit size : #60 - #400
BM	Non-coated micron type. Used in lapping and polishing. Vitrified bond. Only used in wet grinding. Grit size : Micron G45, G30, G15
NBM	Nickel-coated micron type. Used in lapping and polishing. Resinoid bond. Mainly used in wet grinding. Grit size : micron G45, G30, G15

Diamond and CBN types

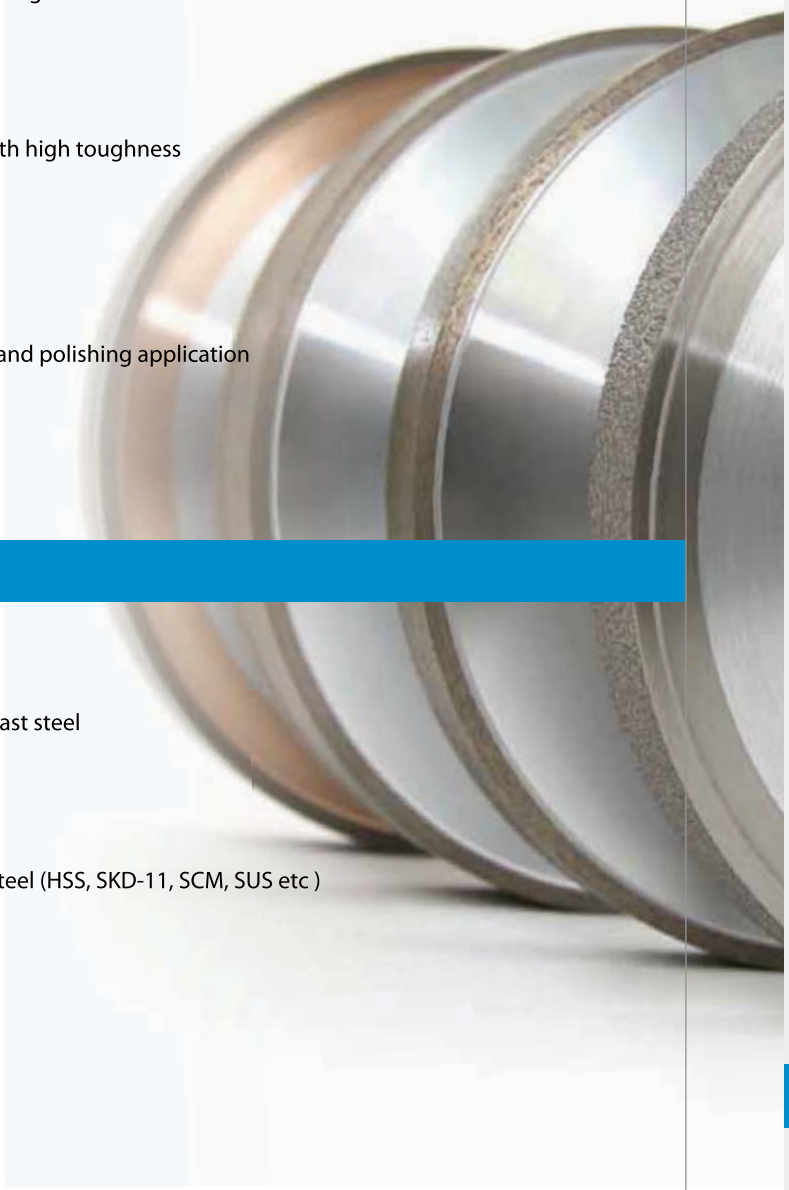
Metal bond

Diamond

SD
Synthetic Diamond Special
Blocky diamond with high toughness
Grit size : #60-#400

SDC
Coated Synthetic Diamond
Blocky, Special diamond with high toughness
Grit size : #60-#400

SDM
Micron Diamond
Blocky, regular shape
Used in precision grinding and polishing application
Grit size : D40/60-D1/2



CBN

CBN
Used for ferrous alloy and cast steel
Grit size : #60-#400

CBS
Special CBN for hardened steel (HSS, SKD-11, SCM, SUS etc)
Grit size : #60-#400

CBM
Micron CBN
Used in precision grinding
Grit size : D40/60-D2/4

Bond modifications

Resinoid

BA	Good elasticity. Depth of grinding is about 10 µm. Mainly used in micron size abrasive and grinding of cemented carbide, hardened steel and PCD (Polycrystalline Diamond).
BB	Heat transfer is excellent for dry gridning. Especially effective with CBN for HSS regrinding. Mainly used for cup type wheels.
BC	Heat transfer and shape maintenance are very good. Applied for fluting of endmill, reamer and drill(HSS).
BCT	Used in CNC machines with cup type(11V9, 12V9).
BD	Very soft. Low noise and good finish shape. Used in general grinding of cemented carbide, ceramic and glas
BE	Used in heavy duty grinding with CBN for HSS grinding. Can be applied under dry condition.
BG	Standard bond for all kinds of workpieces. Applied for profile, face, cylindrical and centerless grinding.
BH	Shape maintenance and heat transfer are very good. Applied for profile and face grinding.
BP	Lubricant bond. Same applications as BG but harde.r Can be applied under dry condition.
BQ	Used for finishing of glass and quartz.
BX	Good cutting ability. Applied for fluting of endmill, reamer and cemented carbide by down feed method.
BXT	Same application as BX bond but harder.
BXC	Used for cermet and ceramic insert grinding.
PAE	High temp polyimide bond for micron carbide tools.
PA8	High temp polyimide bond for small to middle size carbide tools.
BMX	Hybrid bond for heavy stock removal in carbide tool grinding. Heavy stock removal / Good edge holding.

* Note: The bond application according to hardness is as follows.

Wheel type	Soft ---------- Hard
D11V9	BG ----- BE ----- BCT
B11V9	BB ----- BE ----- BCT
1A1	BA ----- BP ----- BG ----- BH ----- BX
1A1R	BD ----- BG ----- BH
4A2/6A2/2A2T	BA---- BB---- BG---- BE---- BH---- BC---- BX---- BXT

Bond modifications

Vitrified

VB General bond for CBN Wheel
Available for bearing , cam shaft , roll, velocity ball joint and die grinding

VBT Improved versin of VB bond to minimize the machining load
Used with VB bond together for better grinding performance

VE Normally used for better grinding performance and surface roughness
Good to reduce machining load but wheel life is less than VB bond

VA Can be applied for both Diamond and CBN
For CBN application, its grinding performane and wheel life is intermediate between VB and VE
For Diamond application, it's harder than VD so suitable for longer wheel life

VD General bond for Diamond wheel
Used for grinding of cemented carbide, PCD and PCBN materials

VCL Suitable bond for crushing wheel
Its grinding performance is better than VD but life time is less than VD bond.

VH Due to good grinding performance, it's a good solution for chipping issue
Specialized bond for PCBN materials and honing stones
Its wheel life is less than VD and VCL bonds

Bond modifications

Metal

MB21 Bronze.
Widely used for glass and lens application.

MC9 Bronze and Iron.
Harder than MB21.
Specialized bond for better wheel life of glass and lens application.

MA Bronze.
Widely used for ceramics, hardened steel and cemented carbide.

MF Bronze.
Used for profile wheels which need an edge for sharp grinding of hardened steel and cemented carbide.

MP1 Bronze and Cobalt.
Used for profile wheels which need an edge for sharp grinding of cemented carbide.

ME4 Bronze and Cobalt.
Used primarily for grinding of vehicle glass on an automatic operating machine.

MG7 Iron.
Generally used for automotive glass and CNC machine.

MG21N Iron.
Primarily used for automotive glass on CNC machine for better wheel life.
Harder than MG7.

MX32 Specialized bronze bond for better grinding performance.
Specialized bond for general grinding of cemented carbide.

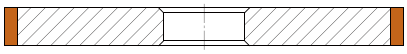
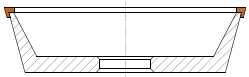
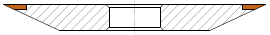
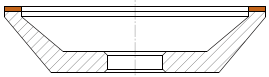
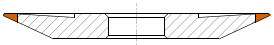
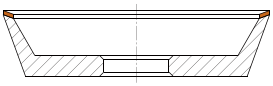
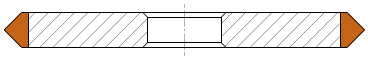
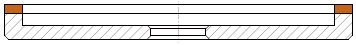
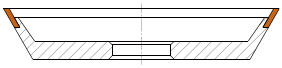
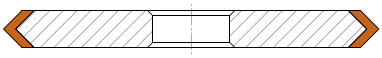
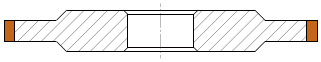
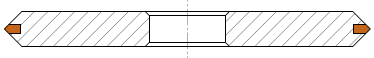
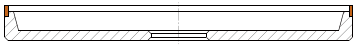
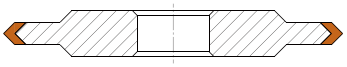
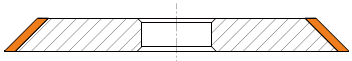
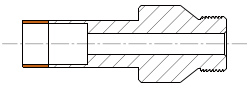
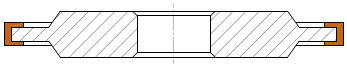
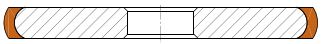
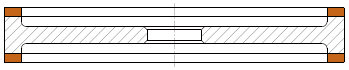
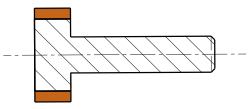
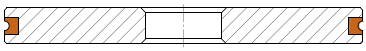
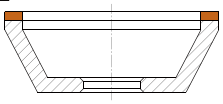
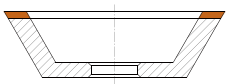
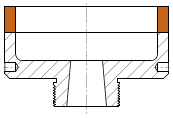
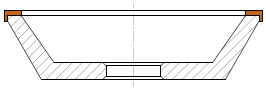
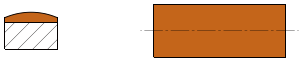
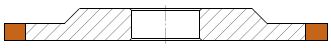
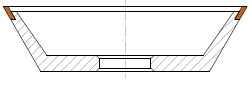
MX4 Specialized bronze bond.
Softer than MX32.
Proper for rough grinding of cemented carbide and cermet.
Can be applied for Sapphire grinding.

MFS Specialized bronze bond
Softer than MX4.
Proper for finish grinding of cemented carbide and cermet.
Can be applied for Sapphire grinding.

MX56 Specialized bronze bond.
Generally used for diamond grinding.
Suitable for polishing (Grit size : # 3000 - # 5000).

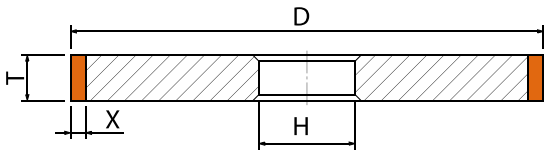
MX57 Specialized bronze bond.
Suitable for electrolytic polishing and crushing grinding.

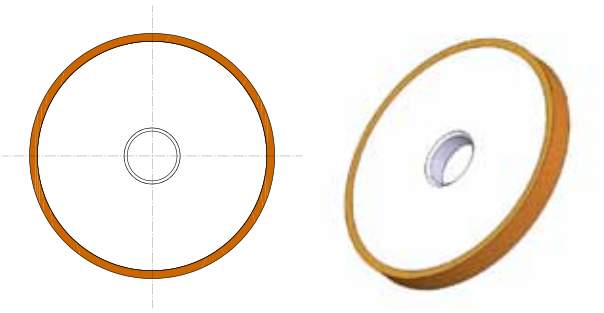
Wheel shapes and key dimensions

Type	Type	Type
1A1 	4A2 	11Y9 
1A8 	4B2 	12A2 
1A1R	4M1 	12V4 
1E1 	6A2 	12V9 
1EE1 	6A2C 	14A1 
1E6Q 	6A9 	14EE1 
1V1 	6F2 	14U1 
1FF1 	9A3 	DW 
1FF6Y 	11A2 	BUL 
2A2T 	11B2 	HH1 
2FF2 	11C9 	HMF 
3A1 	11V9 	PEL 

Wheel shapes and key dimensions

1A1





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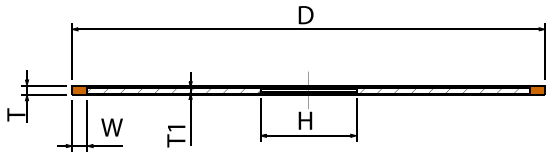

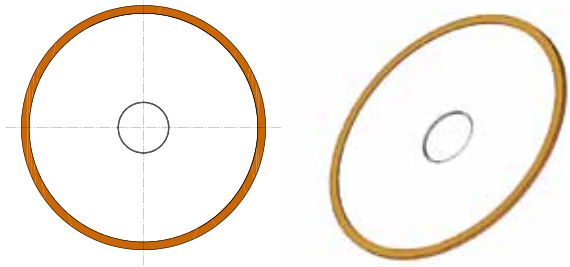

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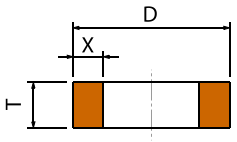

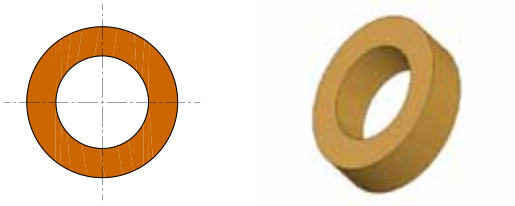

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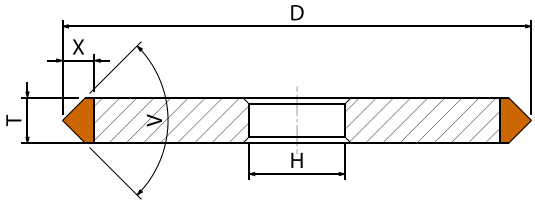

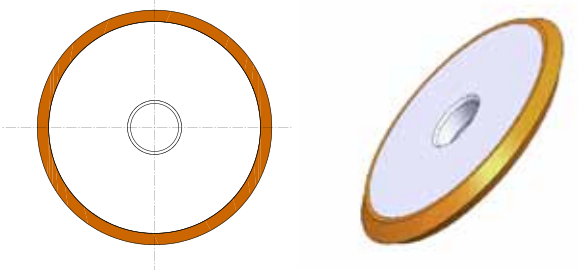

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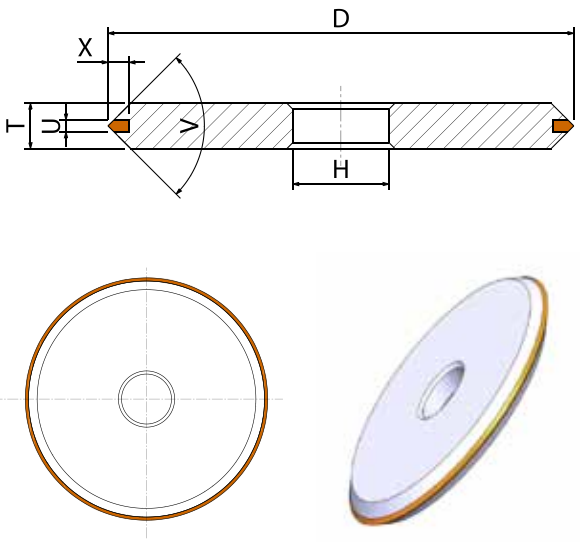

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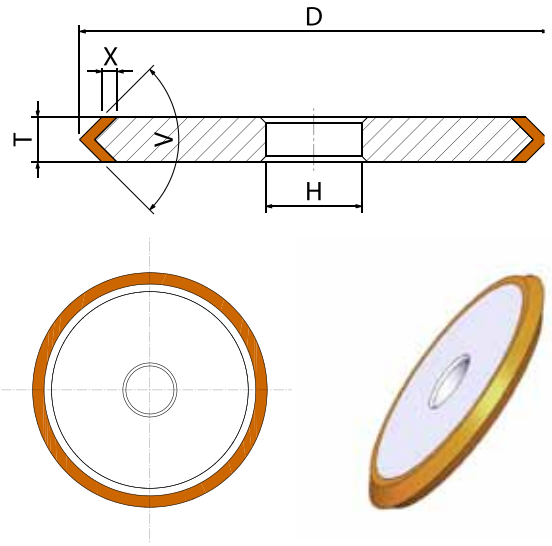

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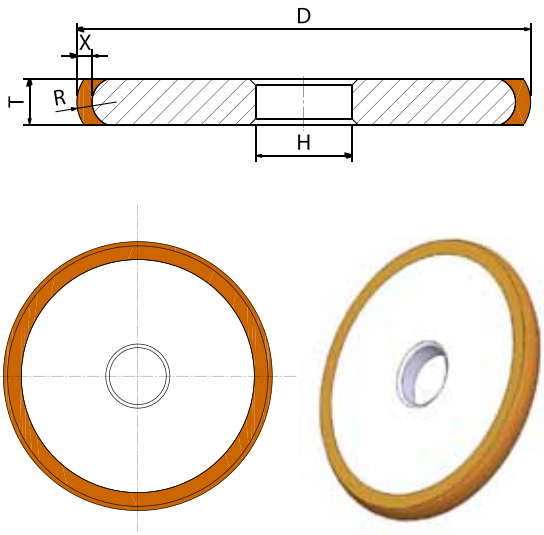

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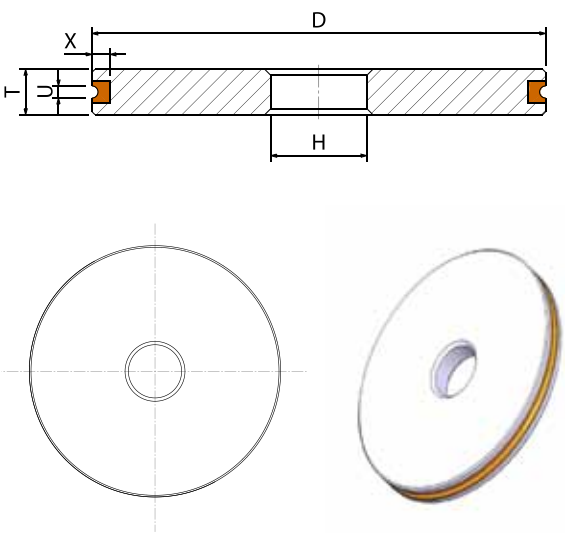
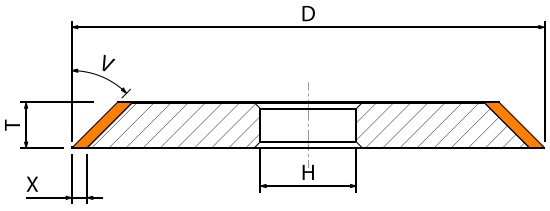
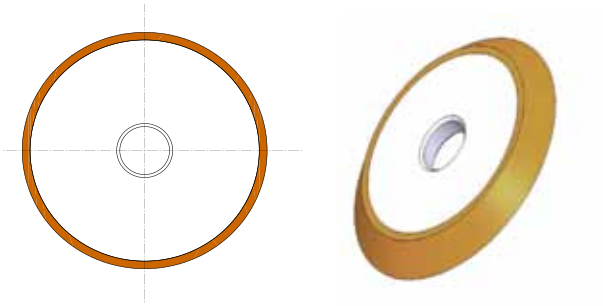


Wheel shapes and key dimensions

1V1





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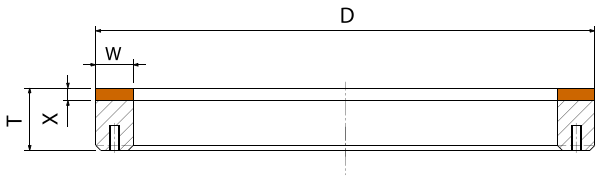

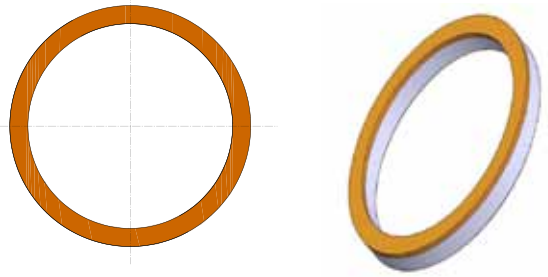

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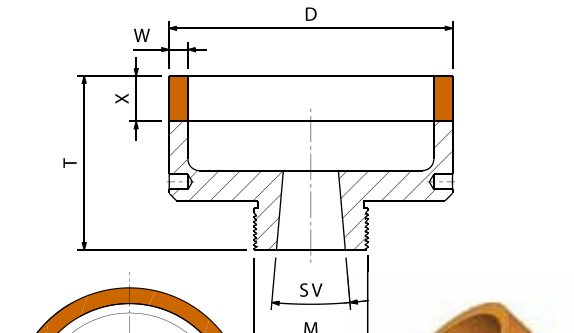

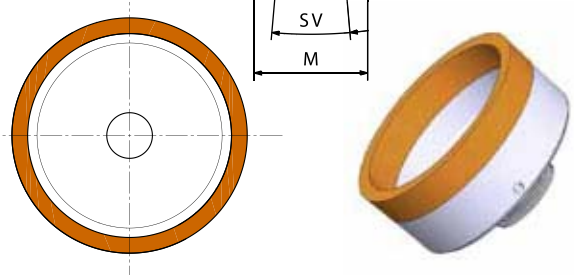

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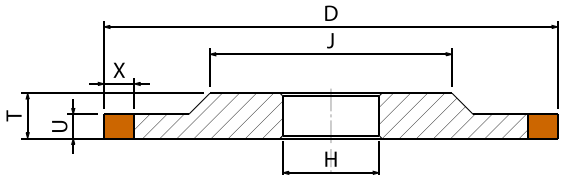
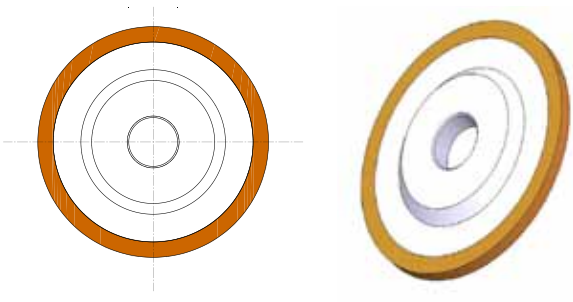
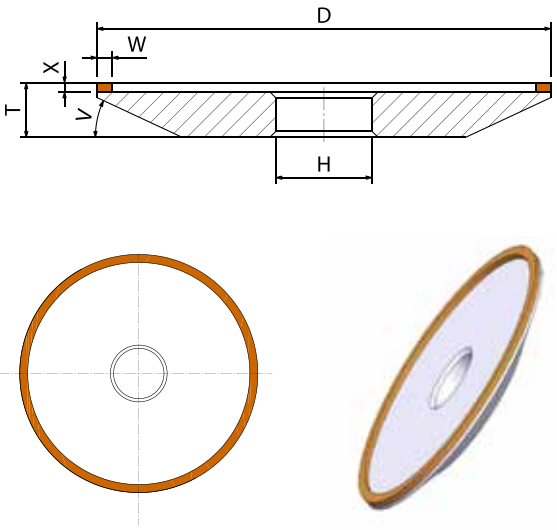




4A2



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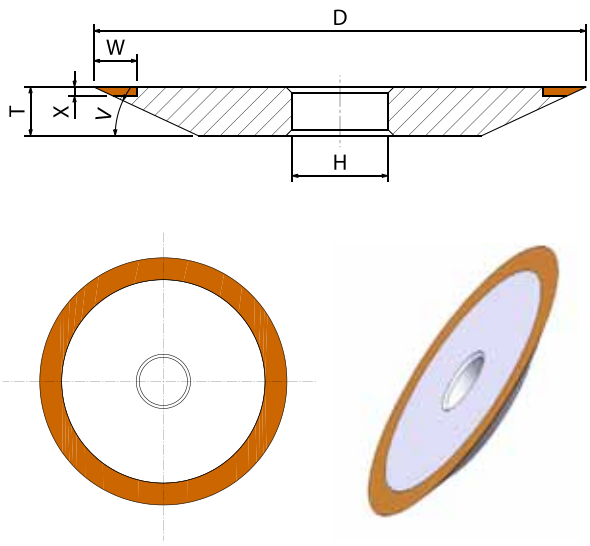
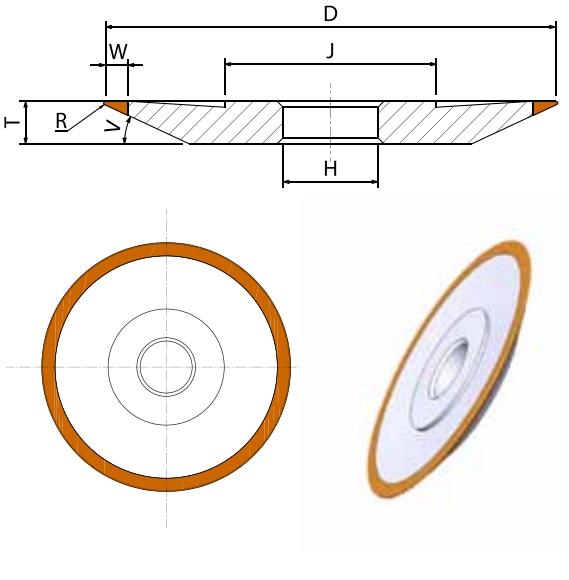
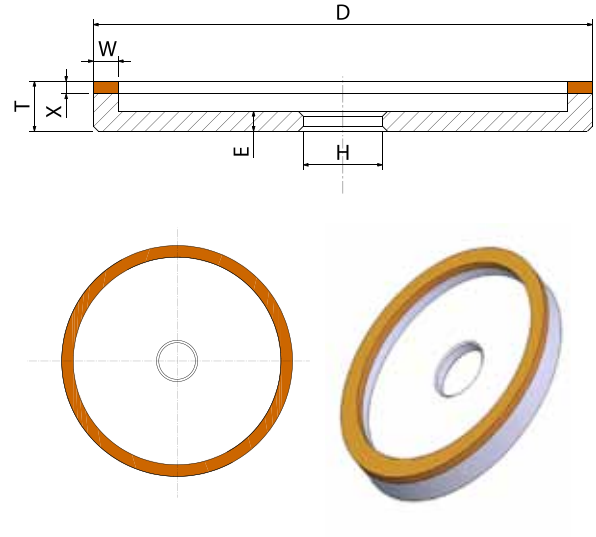


4M1

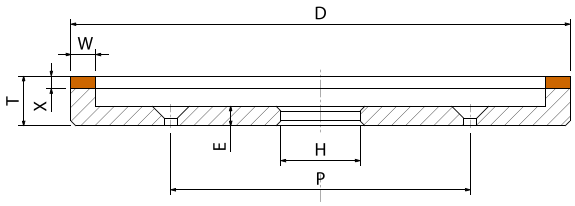


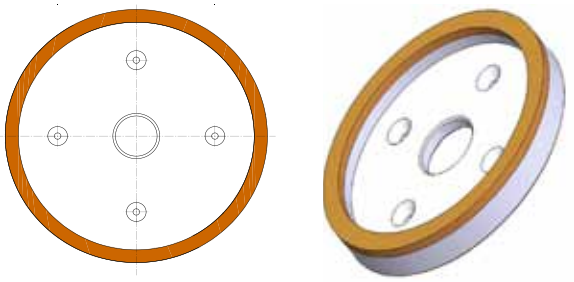
6A2



Wheel shapes and key dimensions

6A2C





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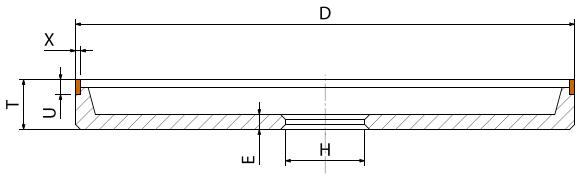

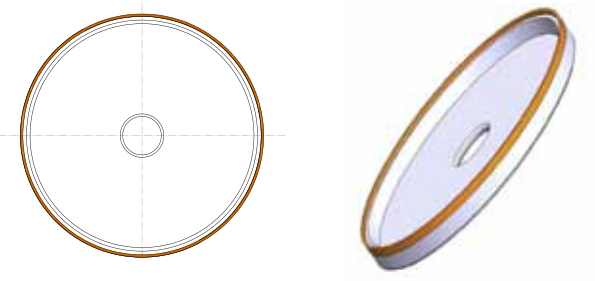

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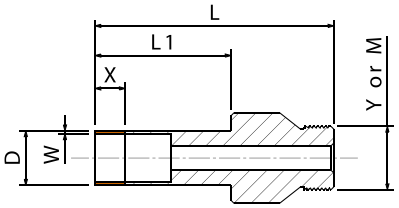
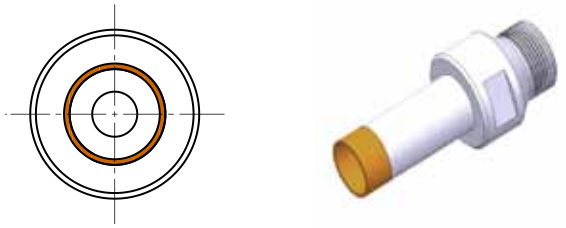
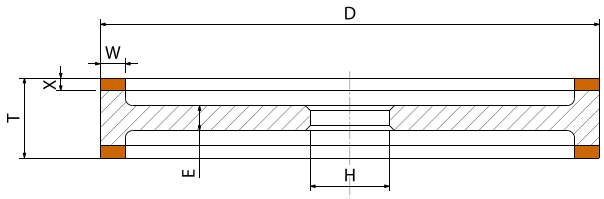
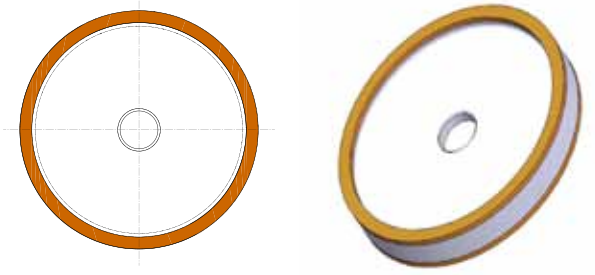




9A3





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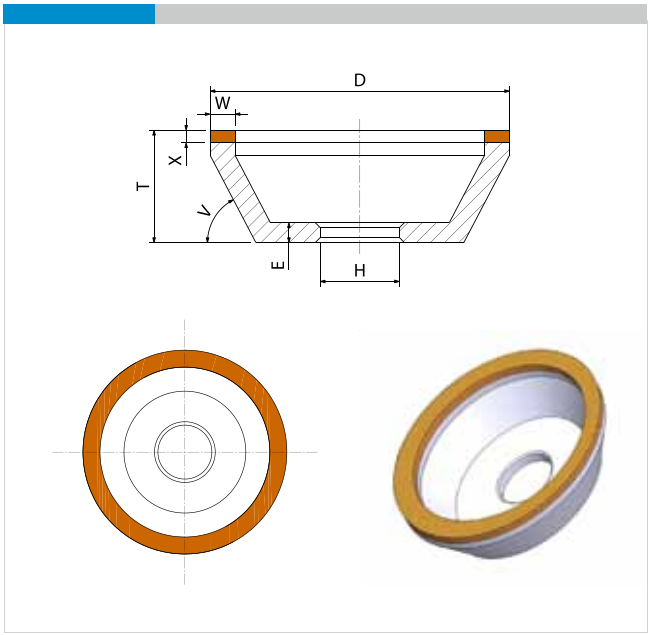

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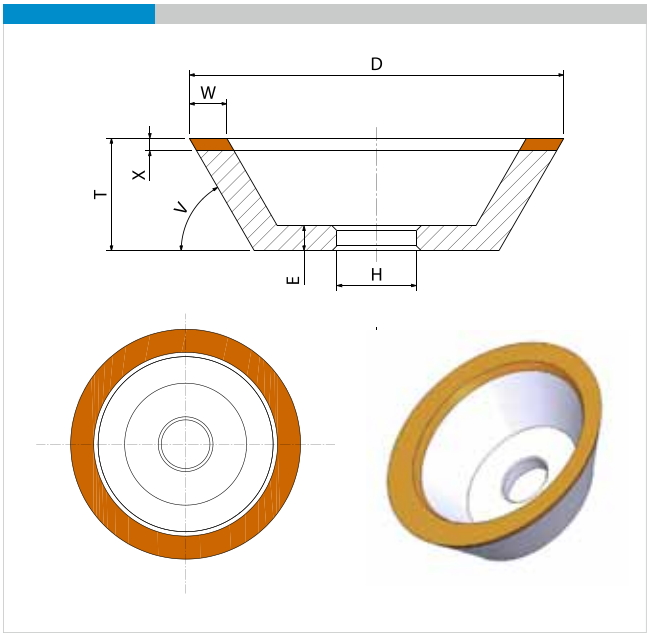

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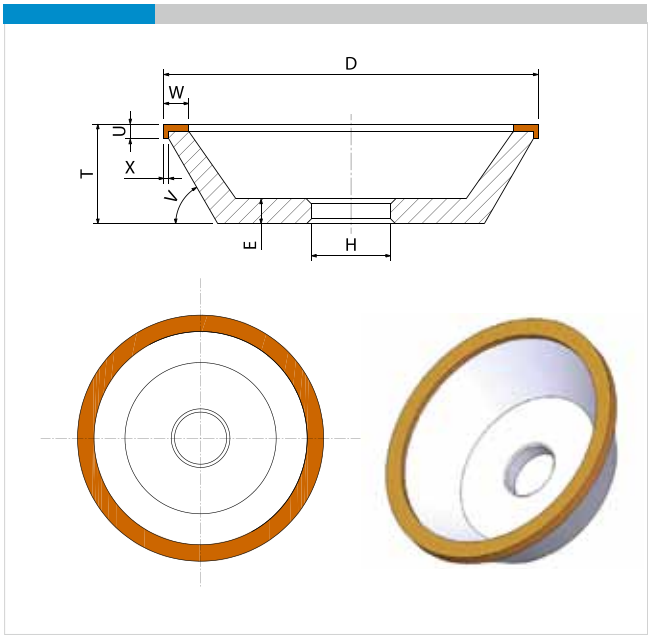
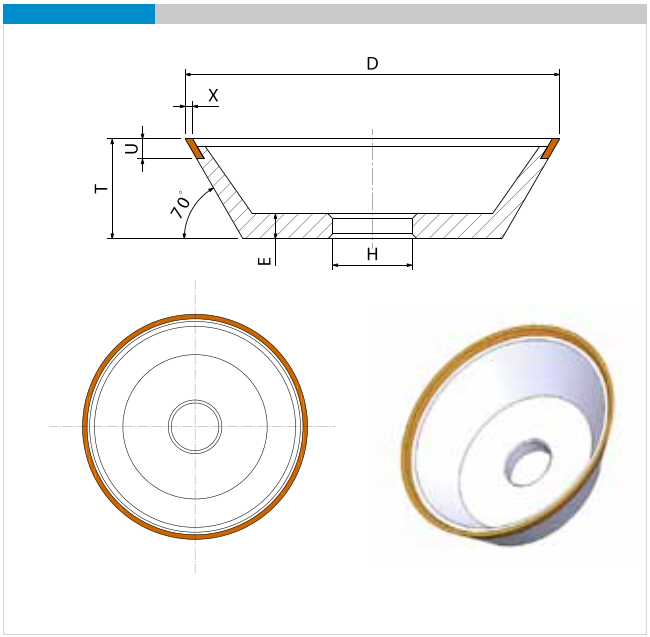
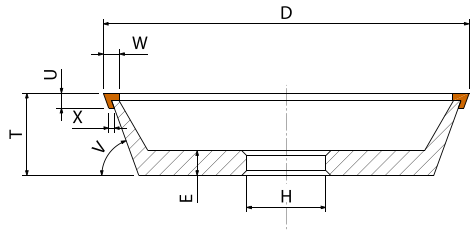


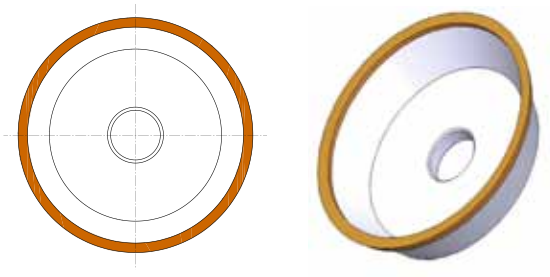
11V9



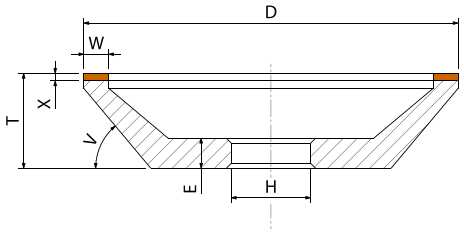
Wheel shapes and key dimensions

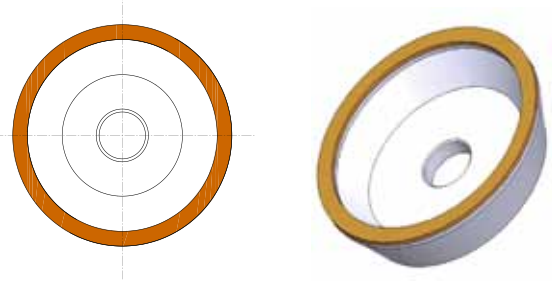
11Y9



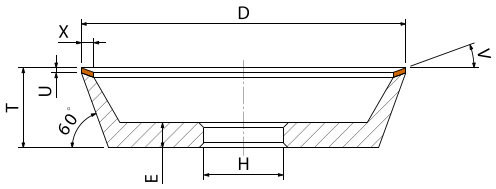


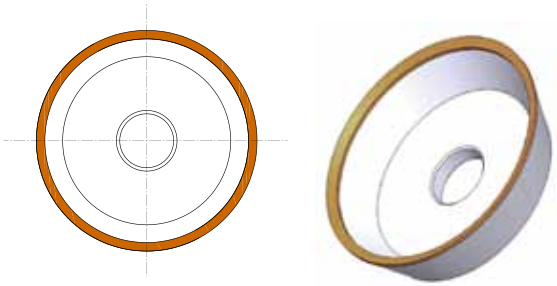
12A2



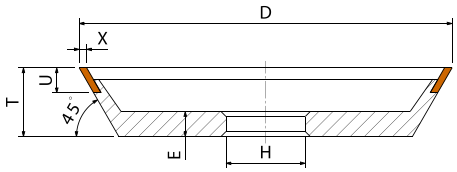


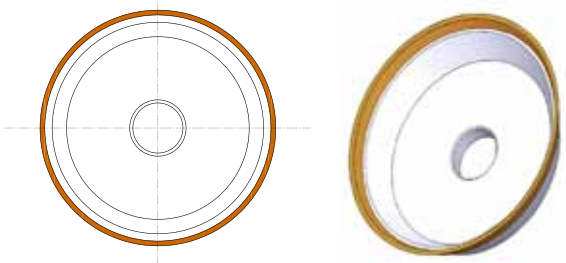
12V4





12V9





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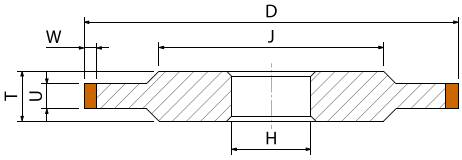

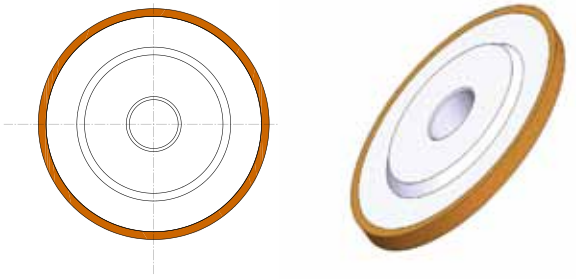

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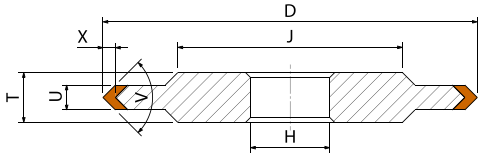

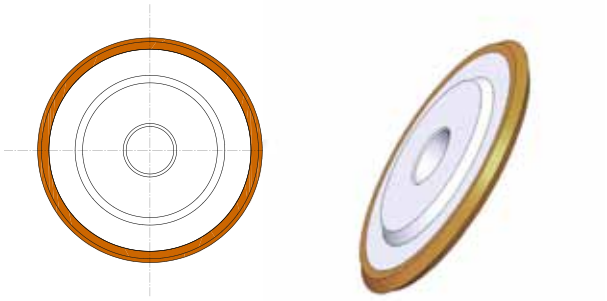

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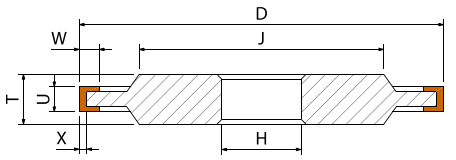
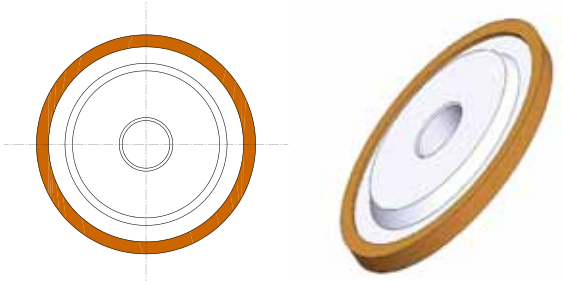
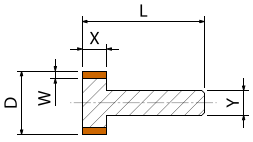
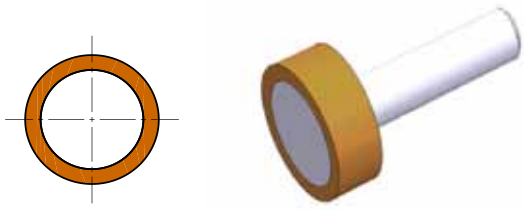




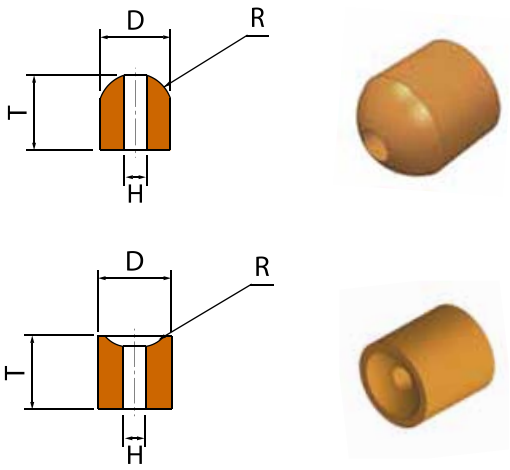
DW



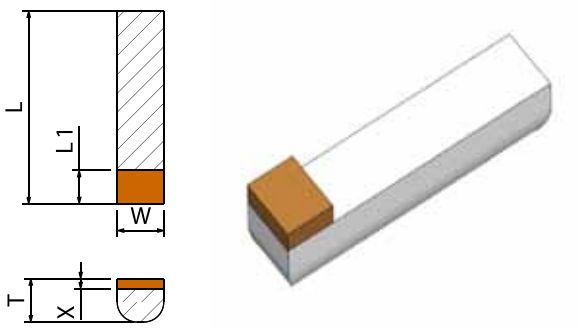


Wheel shapes and key dimensions

BUL



HH1



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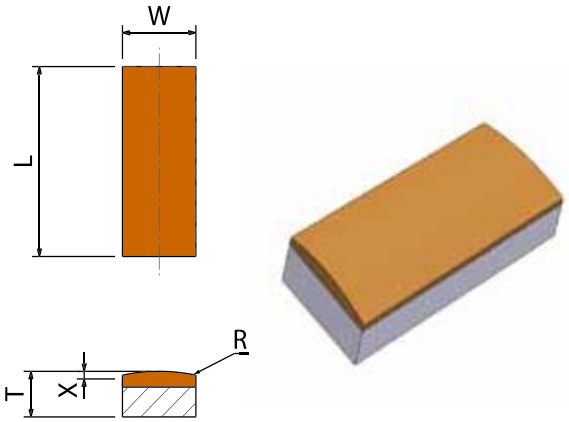
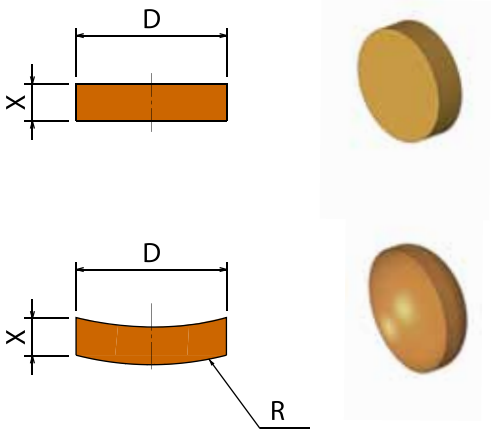


PEL



Quick reference guide

The first section of the wheel shapes and key dimensions is designed to provide you with a quick reference guide in determining the appropriate wheel shape & type.
A drawing of each shape is presented along with letter codes used to indicate the various dimensional characteristics. The key to letter dimensions listed below applies to wheels.

Key to letter dimensions for diamond and CBN wheels

B.C. : Bolt circle
D : Wheel diameter
d : Description of mounting hole
E : Back thickness
H : Hole size
J : Hub diameter
R : Radius
T : Wheel thickness
S : Back angle
L : Length of types DW, HH1, HMF, 2FF2, 6F2
n : Number of mounting holes
U : Diamond face for types 3A1, 14A1,14EE1. 14U1 and pencil edgers insert length for types 1E6Q, 6A9,11C9. 11V9. 11Y9, 12V9
V : Face angle for types 1V1, 4B2, 11B2, 12V4 included angle for types 1E1, 1EE1, 1E6Q, 14EE1
W : Rim width
X : Diamond and CBN depth
K : Inside flat diameter
Y : Shank diameter for type DW, 6F2

* Please specify the dimensions if not filled in our tables.

General information

General information

Diamond grinding wheels

Diamond

The diamonds used in the manufacturing of EHWA diamond grinding wheels can be classified into two categories: natural diamonds and synthetic diamonds. Ever since synthetic diamonds were first introduced in 1957, their applications have been steadily increasing. Now they are accepted as the principal material for diamond grinding wheels.

Two important achievements in the history of synthetic diamonds are the development of strong, tough diamond grits used for saw blades and the improvement of grits for resinoid bonds. Some grits for resinoid bonds are coated with metal which enables the resinoid bond grinding wheels to achieve better performance.

Diamond powder is commercially available in 50 grades, and each grade has its own unique features. Diamonds may be classified into the following three categories in terms of bonding method:

- **Resinoid bond**
- **Metal bond**
- **Vitrified bond**

The grit types and grit sizes of grinding wheels can be selected depending on workpieces, bonds, and grinding conditions. To help us design the grinding wheels best suited to your purpose, please refer to “How to order diamond and CBN wheels” on page 5 and provide us with the necessary information.

Concentration

Concentration is the content of diamonds in a unit volume of a grinding wheel.
When content is 25 volume %, concentration is 100, which is equivalent to 4.4cts/cc of diamond in the grinding wheel. The relationship among grit content (in volume %), concentration, and diamond content (in cts/cc) is as follows:

Grit content (volume%)	Concentration	Diamond content (CT/CC)
25	100	4.4
18.75	75	3.3
12.5	50	2.2
6.25	25	1.1

As illustrated above, the price of a grinding wheel largely depends on its concentration. Since the appropriate concentration of a wheel depends on work materials, grinding conditions, etc., please refer to “How to order diamond and CBN wheels” on page 5 and supply us with the necessary details.

Grit size

Diamond grit sizes are classified into 22 grades as shown in the following table. The nominal grit size of a grinding wheel indicates the coarsest size grits which are present in the wheel. For instance, the grits in the #140/170 range pass through a #140 sieve and are trapped by a #170 sieve. The grit size in this range is noted as #140.

Grit size classification by sieves is only feasible up to #325 mesh. After this, the grit size is still indicated by number (#...), but the method of classification is different. Grit sizes can be more accurately understood by correlating them to their respective mesh sizes and grit size scatter in diameter (see chart below).

Normal grit size (mesh)	Grit size range (mesh of grit use)	Fepa	Normal grit size (mesh)	Grit size range (mesh of grit use)	Fepa
16	16/20		200	200/230	D 76
20	20/30	B 852	230	230/270	D 64
30	30/40	B 602	270	270/325	D 54
40	40/50	B 426	325	325/400	D 46
50	50/60	B 301	400		
60	60/80	B 252	600		
80	80/100	B 181	800		
100	100/120	B 151	1000		
120	120/140	B 126	1500		
140	140/170	D 107	2000		
170	170/200	D 91	3000		

Bond

There are three alternative bonding methods: resinoid bond, metal bond, and vitrified bond.

- **Resinoid bond**

Resinoid bond grinding wheels are manufactured by using resinoid bonds to bond diamond grits.
There are two types of resinoid bonds: the phenol resin type and the polyimide resin type. The phenol resin type is currently in more common usage.
Resinoid bond grinding wheels have good elasticity, fine surface finish, and high grinding performance. They are effective for:
(1) grinding of cemented carbide
(2) combination grinding of cemented carbide and hardened steel
(3) grinding of cermet
(4) precision grinding of magnetic materials, glass, ceramics, etc. Polyimide wheels are recommended for heavy grinding and creep-feed grinding.

- **Metal bond**

Metal bond grinding wheels are manufactured by sintering metal powder to bond diamond grits. These wheels are superior in grit retention, and therefore preferred:
(1) when a long service life is required
(2) when wear of the grinding wheel needs to be minimized (such as in form grinding)
(3) in hand grinding of cemented carbide
(4) in profile grinding
(5) in the cutting and grinding of hard, and brittle materials such as ceramics, glass, and quartz
(6) in the cutting and grinding of magnetic materials such as ferrite
(7) in the cutting and grinding of stone
(8) in the cutting and grinding of graphite, etc.
The high grit retention quality of metal bond can also cause grazing or loading. The increase of grinding pressure and of heating due to loading may cause thermal damage to the workpiece. In order to prevent thermal damage, please choose the grinding process, conditions, coolant, dressing intervals, etc. carefully.

- **Vitrified bond**

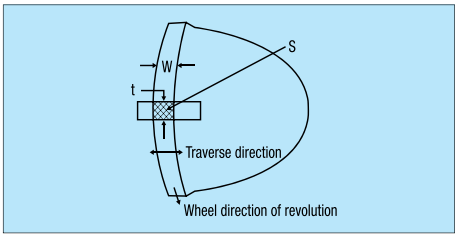
Vitrified bond grinding wheels are manufactured by using vitrified bonds to bond diamond grits. As vitrified bonds are porous, vitrified bond wheels can overcome the forming and dressing difficulties encountered with resinoid bond and metal bond grinding wheels. Vitrified bond wheels are used to grind cemented carbide, sintered diamond tools, etc.

Wheel diameter

The heat produced by grinding with diamond wheels is cooled by the grinding fluid and by air. If the diameter of the wheel is small, the grits heated in the grinding process may not have sufficient time to be cooled before they come into contact with the workpiece in the next rotation. This results in progressive heat accumulation as grinding continues. And this in turn accelerates the wear of the diamond grits themselves as well as the deterioration of the resinoid bond in the vicinity of each grit, resulting in the early pull-out of the diamond grits.
It is always recommended that the diameter of the grinding wheel be made as large as possible. In high removal grinding, the heating is increased and the wheel life is shortened ; thus, the costs of grinding are also increased. For this reason, too, it would be advantageous to make the diamond wheel diameter as large as possible.

Wheel rim width

When the workpiece and the diamond wheel come into surface contact, stock removal is performed on the contact surface (s). The size of the contact surface is determined by the wheel rim width(w) and the contact length (t).



Stock removal is the cutting of the workpiece by the diamonds at the contact surface.
The force between the diamond wheel and the workpiece depends on the machine rigidity, the work supporting system, and the work type.
When the pressing force is constant, the surface pressure on the diamond wheel(kg/mm2) increases as the wheel width decreases.

The diamond grits then give a higher cutting performance, and the stock removal rate increases. This is of great practical significance in plunge grinding with a cup wheel or a straight wheel.
For greater efficiency, the wheel- -workpiece contact area should be made as small as possible. On the other hand, the life of the diamond wheel increases as the wheel width increases. The width of the wheel should be determined after taking into consideration the required working efficiency, the machine rigidity, and other pertinent factors.

Machine

The grinding machine should have sufficient rigidity. Vibration of the table or the spindle will most likely cause the forming of an oscillation mark" or severe wheel wear. In order to achieve the optimum grinding efficiency, enough machine power is required to ensure stabilized peripheral speed of the wheel and stabilized infeed. A machine without sufficient power will result in insufficient wheel speed, abnormal wear, and decreased grinding efficiency. It is always best to use a vibration-free, highly rigid grinding machine with sufficient horse power.

Mounting of grinding wheel

If the wheel is not properly set and if the periphery and the sides of the grinding wheel attached to the machine spindle are subject to vibration, problems arise during grinding, including:
(1) Oscillation marks on the workpiece.
(2) Machine begins to vibrate; grinding noise increases
(3) Wheel life is notably shortened.

To avoid these problems, the grinding wheel must be mounted properly.
When a cup wheel or dish wheel is mounted on the machine, side runout should be less than 0.02mm. Likewise, peripheral runout should be less than 0.02mm when a straight wheel is mounted. If the wheel runout is over 0.02mm, reduce runout by following the procedures below:
(1) Fasten the grinding wheel gently on the flange fixed to the machine.
(2) Check the periphery runout using a dial indicator.
(3) Reduce the periphery runout by gently hammering the periphery of the grinding wheel.
(4) After adjusting as instructed above and tightly fastening the grinding wheel, recheck the periphery runout with the dial indicator.
The above procedures are valid only if there is a space between the internal diameter of the grinding wheel and the flange.
If there is no space, the runout of the grinding wheel itself must be adjusted.

Truing and dressing

If the periphery runout is severe when the grinding wheel is mounted, or if profile wear of the straight wheel or cup wheel is found, the runout and profile of the wheel must be adjusted. Truing is the procedure of adjusting the runout and profile of the wheel. It involves shaving off the diamond grits and the bond to correct the runout and the profile of the wheel. The diamond grinding wheel cannot be used immediately after the truing procedure as the diamond grits are not properly exposed ; therefore, the wheel is not in prime condition to be used. To improve free-cutting ability, the bond must be dug out and the diamond grits exposed onto the surface of the wheel. This process is called dressing. Diamond grinding wheels cannot satisfactorily perform unless the above procedures are followed correctly.

• Selection of dressing stick

In order for the truing of the diamond grinding wheel to be effectively performed in a timely manner, the grit size of the silicon carbide truing wheel must be 2 grades coarser than that of the diamond grinding wheel. As shown below, the grade of the silicon carbide wheel must be relatively hard.

Grit size of diamond wheel	Silicon carbide wheel for truing
#80 or coarser	C46 - M
#100 - #200	C60 - M
#230 - #325	C80 - M
#400 or finer	WA200 - G

• Truing methods

There are four truing methods:
(1) Brake dresser
(2) Abrasive stick
(3) Mild steel
(4) Tool post grinder

General information

Diamond grinding wheels

1. Brake dresser
For truing with the wheel still mounted on the machine, the brake dresser is the best option of the above four methods by providing fast, simple, and stable truing.
2. Abrasive stick
Truing of the diamond grinding wheel can also be performed by grinding the abrasive stick fixed on the chuck with the grinding wheel. Please pay careful attention during truing, as this method tends to make the wheel edge round.
3. Mild steel
This method does not require any special devices and is easy to accomplish by grinding the mild steel with the diamond wheel. The diamond wheel could be damaged, however, if it is not sufficiently flooded with grinding fluid while grinding.
4. Tool post grinder
This truing method involves removing the diamond grinding wheel from the machine and grinding it with a silicon carbide wheel on another machine. Vibration of the diamond grinding wheel could possibly occur during the resetting of the trued on the first machine.

• Selection of dressing stick

Since the purpose of dressing the diamond grinding wheel is to expose the diamond grit by removing the bond only, the grit size of the stick should be 2 grades finer than that of the diamond grinding wheel.
Below is a guide to selecting a dressing stick:

GRIT SIZE OF DIAMOND GRINDING WHEEL	STICK FOR DRESSING
#80 or coarser	WA120 - G
#100 - #200	WA200 - G
#230 - #325	lapping stick
#400 or finer	lapping stick

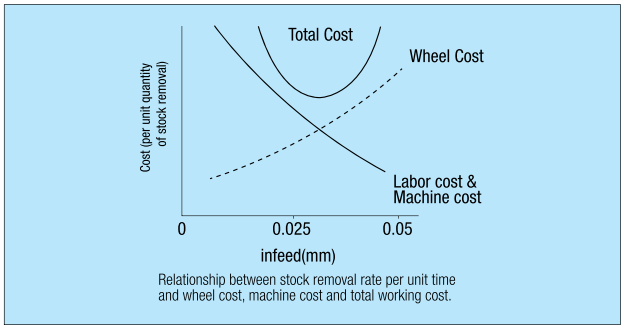
• Dressing with stick

A diamond wheel is dressed by pushing the stick on the surface of the diamond grinding wheel by hand. Coolant must be used. In case of dry dressing, a wet stick should be used. When using a lapping stick, dry dressing is recommended.

Analysis of work conditions

In the past, when diamond wheels were “expensive and precious tools”, the life of the wheel was considered the most important factor. Today, however, diamond grinding wheels are often evaluated based on total working costs. Total working costs are:
(Wheel cost) + (Other expenses, including cost of labor).

Recently, as labor costs have been soaring, the component of “other expenses” has been increasing steadily, Consequently, grinding efficiency has become more important.
Making a graph such as the one shown below can help in finding optimum working conditions which minimize the total working costs.



Relationship between stock removal rate per unit time and wheel cost, machine cost and total working cost.

• Peripheral speed

Wheel life, stock removal rate, and surface finish all depend largely on the peripheral speed of the wheel.
It is therefore very important to find the optimum peripheral speed for the diamond wheel. The table below shows recommended peripheral speeds:

Resinoid bond	Metal bond
Wet 1400 - 1600 m/min	Wet 1000 - 1800 m/min
Dry 900 - 1200 m/min	Dry 600 - 900 m/min

Peripheral speed is a function of wheel diameter and spindle speed(rpm).

• Grinding fluid

Since regrinding is performed by physically watching the point of contact between the wheel and the workpiece, dry grinding is usually employed.
When the wheel- -workpiece contact area is relatively large, the heat from grinding increases. For this reason, dry grinding may result in workpiece burning, wheel loading, bond wear, and other conditions which lead to a shortened wheel life. Consequently, the proportion of wheel cost to total costs increase. In such a situation, then, wet grinding is recommended. In wet grinding, the grinding fluid should be applied directly to the point of contact between the wheel and the workpiece. In heavy grinding or in creep-feed grinding, when heat increases, use a grinding fluid with a high lubricating performance and apply the fluid to the grinding point under high pressure.

• Infeed

Infeed is an important factor in determining grinding efficiency. However, a too-high increase in infeed in an attempt to improve the grinding efficiency can shorten the wheel life.

To determine the proper infeed, follow the guide given below. In form grinding, however, increase the depth of the cut and decrease the feeding speed to prevent deviation from the shape.

Grit size of diamond grinding wheel	Depth of cut
#100 - #120	0.02 - 0.03 mm
#140 - #200	0.01 - 0.02 mm
#230 or finer	0.01 mm or less

• Surface finish

Because the surface finish of the workpiece depends on many factors--the grinding method and the workpiece material as well as the grit size of the diamond--it is difficult to make specific recommendations for surface finishing. In order to achieve a high rate of material removal and a good surface finish, grinding should be accomplished in two separate processes. The diamond grit sizes should be as follows:

Rough	Finish
#100 #120 #140	#270 #325 #400 #600

In any case, surface finish can be improved by spark-out.

General information

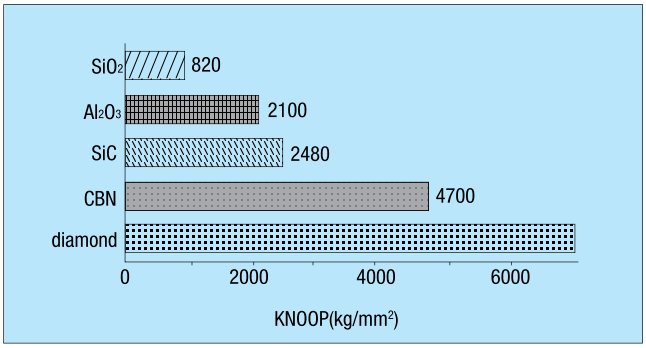
Diamond grinding wheels

CBN

CBN (Cubic Boron Nitride) is the super abrasive used for steel grinding. CBN is crystallized from the nitric material in boron using a high pressure, high temperature method similar to the one used in diamond synthesis.

- **Characteristics of CBN**

Next to diamond, CBN is the second hardest material known on the earth. As shown by the figures below, it is harder than both Al_2O_3 (abrasive for WA and A grinding wheels) and SiC (abrasive for GC and C grinding wheels).
When considering the hardness only, diamonds would seem to grind steel easily, being the hardest materials. But at temperatures of 600-700°c, diamonds in contact with air begin to wear due to oxidation.
Also, since diamonds are basically composed of carbon, they react to the iron in steel, resulting in diamond wear. In contrast, CBN does not wear in these conditions, as it is stable up to 1370°c and does not react to iron.



Availability of CBN aerasives

CBN abrasives are classified into two types: metal- coated and uncoated. Metal-coated CBN is used mainly in resinoid bond grinding wheels, and uncoated CBN is used in electroplated metal bond and vitrified bond grinding wheel.

Concentration (see page 40)

Grit size

Normal grit size (mesh)	Grit size range (mesh of grit use)	Fepa	Normal grit size (mesh)	Grit size range (mesh of grit use)	Fepa
60	60/80	B 252	325	325/400	B 46
80	80/100	B 181	400	G 45	
100	100/120	B 151	800	G 30	
120	120/140	B 126	1000	G 15	
140	140/170	B 107	1500	G 9	
170	170/200	B 91	2000	G 6	
200	200/230	B 76	3000	G 3	
230	230/270	B 64	5000	G 1	
270	270/325	B 54			

General information

Diamond grinding wheels

Bond

There are three alternative bonding methods: resinoid bond, metal bond, and vitrified bond.

• Resinoid bond

Resinoid bond grinding wheels are manufactured by using resinoid bonds to bond CBN grits. The resinoid bond CBN grinding wheel has a wider range of uses than other bond wheels. It is mainly used for surface grinding, cylindrical grinding, creep-feed grinding, centerless grinding, double-disc grinding, and internal grinding.

CBN grinding wheel is economical in cases where the workpiece is an iron material with hardness of over HRC50. EHWA has succeeded in developing a resinoid bond which enables the full performance of the CBN grit.

• Metal bond

Metal bond grinding wheels are manufactured by sintering metal powder to bond CBN grits. They are used for the honing and cutting of hardened steel and for accomplishing a high removal rate in the grinding of mid-range hard steel.

• Vitrified bond

Vitrified bond grinding wheels are manufactured by using vitrified bonds to bond diamond grits. As vitrified bonds are porous, vitrified bond wheels can overcome the truing and dressing difficulties encountered with resinoid bond and metal bond grinding wheels.
Vitrified bond wheels are used for high presision grinding with various shapes.

(1) CBN weels
- ① Automotive parts : CV Joint, Gear, Cam & Crank shaft
- ② Tool parts : End-mill, Thread die
- ③ Bearing
- ④ Electronic parts : Motor, Sleeve
- ⑤ Hydraulic and Air pressure machines : Compressor
- ⑥ Fuel pump : Injection nozzle

(2) Diamond wheels
- ① Cutting tools : Ceramic, PCD/PCBN inserts
- ② Surface Grinding : Silicon and Cemented carbide wafer
- ③ Double Disc : Rotor gear
- ④ Honing stones

• Peripheral speed

Wheel life, stock removal rate, and surface finish depend largely on the peripheral speed of the wheel. Finding the optimum peripheral speed for the CBN wheel is therefore very important. The table below shows recommended peripheral speeds.

Resinoid bond
Wet 1750 - 1850 m/min Dry 900 - 1200 m/min

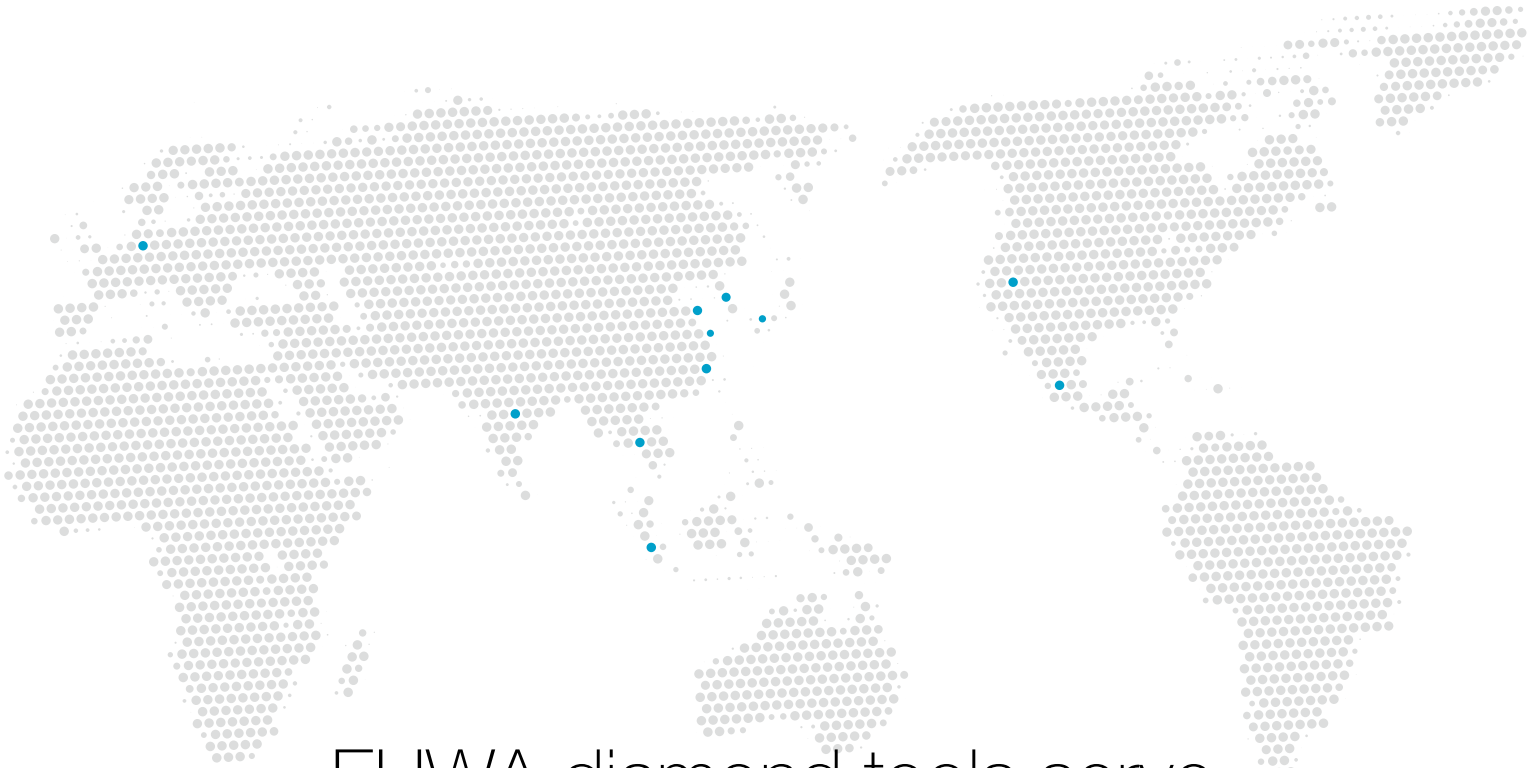
Peripheral seed is a function of wheel diameter and spindle speed (rpm).
However, if the coolant pressure for grinding is kept high enough to keep the wheel from heating, the peripheral speed of the grinding wheel can be raised up to 13000ft/min. If the wheel speed (rpm) increases, the material removal speed can also be increased while maintaining a long wheel life.

• Grinding fluid

There are two types of grinding fluids. One is straight oil (water immiscible) and the other is water soluble. Straight oil is a coolant with an oily ingredient immiscible in water. It lubricates well, but it is an ineffective coolant with poor usability. However, straight oil enable CBN grinding to achieve maximum performance when grinding tough but soft workpieces such as stainless steel, inconel, and waspaloy. Straight oil also enables superior performance in heavy duty grinding.
Water soluble coolants are subdivided into three types: emulsion, soluble, and chemical.
The emulsion type becomes milky and opaque in water. Compared with straight oil, it has the next best lubricating effect, and emulsion type is better than straight oil for cooling. If the working place is not suited to straight oil, the emulsion type is recommended, but the concentration of coolant must be high - - above 5%.
The soluble type becomes translucent in water. Compared with emulsion type, it has the next best lubricating effect, and soluble type is better than emulsion type for cooling. In general grinding, soluble type is sufficient.
The chemical type becomes transparent in water. It is the best fluid for cooling, but the least effective for lubrication. If the chemical type is being used for general grinding, there is no need to change to the soluble type.

Conversion table of surface finish

Rmax(μm)	Ra(μm)	Rms(μm)	Rz(μm)	Rms(μin)	Rmax(μm)	Ra(μm)	Rms(μm)	Rz(μm)	Rms(μin)
0.1	0.02	0.02	0.1	1	2.4	0.41	0.46	2.2	24
0.2	0.03	0.04	0.2	2	2.8	0.48	0.53	2.5	28
0.3	0.05	0.06	0.3	3	3.2	0.54	0.61	2.9	32
0.4	0.07	0.08	0.4	4	3.6	0.61	0.68	3.2	36
0.5	0.09	0.10	0.5	5	4.0	0.68	0.76	3.6	40
0.6	0.10	0.11	0.5	6	4.5	0.77	0.86	4.1	45
0.7	0.12	0.13	0.6	7	5.0	0.85	0.96	4.5	50
0.8	0.14	0.15	0.7	8	5.5	0.94	1.05	5.0	55
0.9	0.15	0.17	0.8	9	6.0	1.02	1.14	5.4	60
1.0	0.17	0.19	0.9	10	7.0	1.19	1.33	6.3	70
1.2	0.20	0.23	1.1	12	8.0	1.36	1.52	7.2	80
1.4	0.24	0.27	1.3	14	9.0	1.53	1.71	8.1	90
1.6	0.27	0.30	1.4	16	10.0	1.70	1.90	9.0	100
1.8	0.31	0.34	1.6	18					
2.0	0.34	0.38	1.8	20					



EHWA diamond tools serve as a promoter of globalization

Since 1975, EHWA DIAMOND has been growing by developing long-term partnerships with customers worldwide and across the industries. EHWA is tirelessly striving to provide the very best customer satisfaction through continuous product innovation and world class service.

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Osan 2


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Pyeongtaek


Seocheon


Cheongju

Overseas


China Fujian


China Weihai


China Shanghai


Indonesia


USA

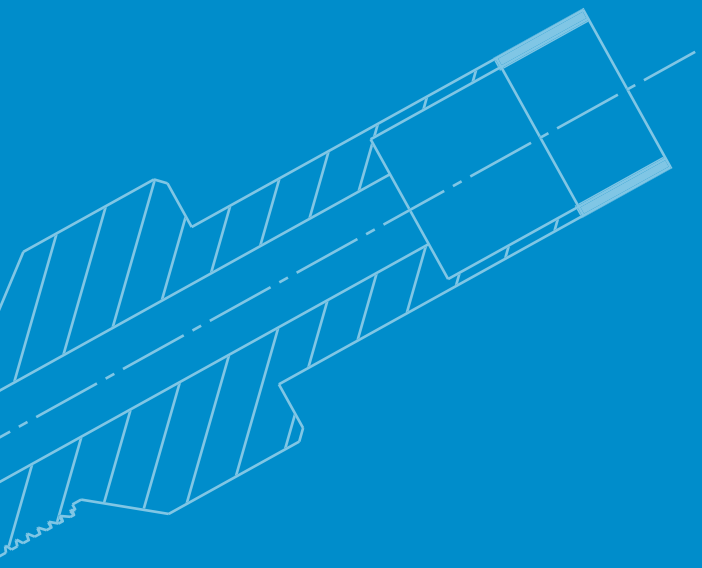

Japan

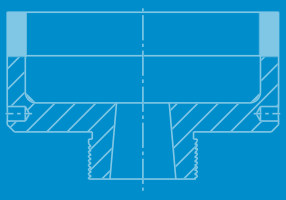

Thailand

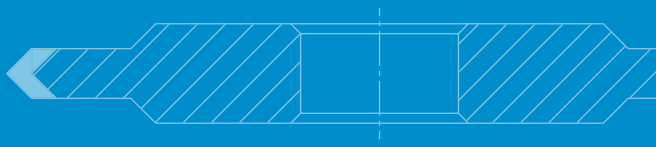

Germany

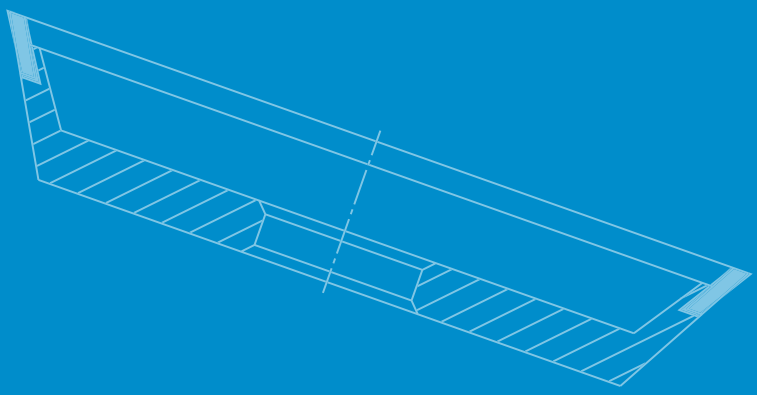

India

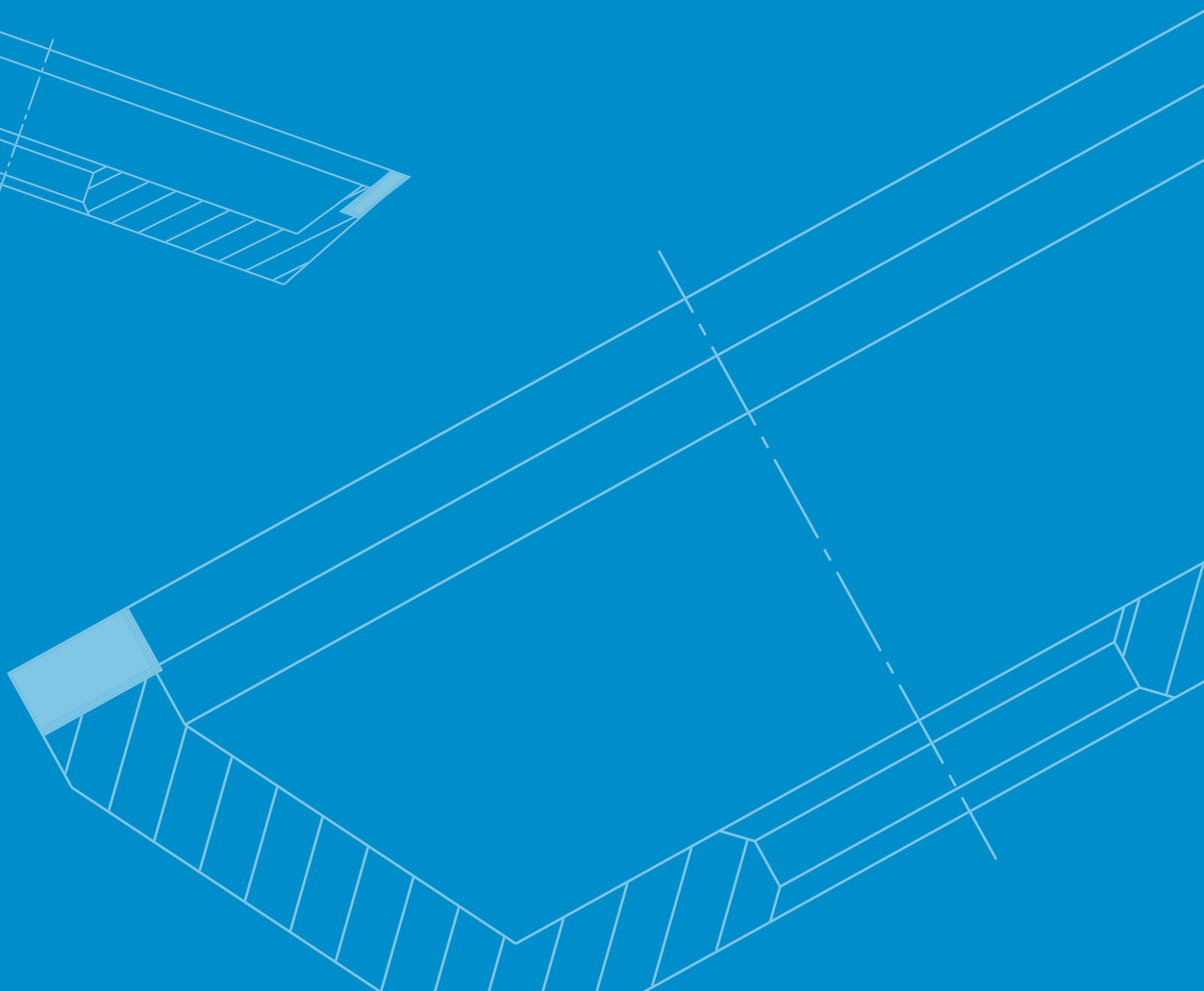

Mexico

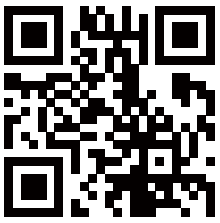












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