MASTER TECHNICS

FROM FIRST STEPS TILL NOW

"MASTER TECHNICS" DOO, a company dealing with production of abrasives was set up in 1994 as a private commercial company located in Ratina, 6 km far from Kraljevo.

The main business activity of the company during the initial business years was production of resin (bakelite) bonded abrasive wheels of various dimensions, quality and shapes. After 10 years of production of such abrasives we have positioned ourselves as one of the leading companies in the branch of grinding, i.e. snagging in foundries, forging works, brickyards and other segments of metal-working industry on the territory of the former Republics of Yugoslavia.

By mid-2004 we started manufacturing vitrified bonded abrasives according to our own technology, to serve the wide needs of grinding in mechanical and metal-working industry, and thus we have diversified our production programme to a large extent, meeting the strict requirements of our customers. By means of professional advice and recommendations for selection of abrasives of adequate quality and fast delivery, we have created a long-term cooperation with our clients in terms od mutual trust and respect, which has resulted in sustained increase of production and placement of our products year by year. About 75% of our production is placed in the territory of the Republic of Serbia, and the remaining 25% is exported, mainly to the neighboring countries.

Today "MASTER TECHNICS" DOO manufactures several thousands of abrasives of various shapes and quality for a wide variety of applications. Innovative technological procedures in the process of usage of raw materials that are procured from renowned and recognised world manufacturers have resulted in the high quality of final products and ranking of our company among the most famous European manufacturers of abrasives.

Grinding wheels are produced and tested according to the acknowledged JUS and ISO standards which guarantee the best possible quality and safety of the production process. Due to the responsible approach to the technological - production process, the company was awarded SRPS ISO 9001/2001 Quality System Certificate in 2007.

In conclusion of this introductory part I would like to inform you that we have continued working on development and application of new abrasives. We expect the forthcoming years to be as challenging as the past ones which will additionally stimulate us to constantly promote both the production process and market placement of our products.

Kraljevo, May 2009
Radmila Đurović, Director

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Grinding is a process of material modelling by removal of sawdust with abrasive grains of various sharpness. In order for the removal of sawdust to be efficient, the abrasive grain must at high speed effect the material that is being ground. Grinding is performed by grinding tools which have a wide variety of application, ranging from the coarsest grinding to precision grinding of finest surfaces.

A grinding tool (abrasive wheel) consists of an abrasive grain and a bond. The abrasive grain performs the cutting with its sharp edges, whereas the role of the bond is to hold the abrasive grains together and provide mechanical strength to the abrasive wheel. The bond has to hold the grain while it is sharp and enable its fall once it becomes blunt. The efficiency of the abrasive wheel is determined by the grinding effect, quality of the treated surface and durability.

SELECTION OF ABRASIVE WHEEL

Depending on the material being ground and the requested grinding quality, in addition to the proper use of wheel, it is very important to select the proper wheel.

When selecting a wheel, it is necessary to choose an adequate type and size of abrasive grain, hardness, structure and type of bond.

SELECTION OF ABRASIVE GRAIN

The selection of abrasive grain depends on its physical features and the material that is being ground. We produce abrasive wheels from various types of electrofused corundum and silicon carbide. An ideal abrasive grain tends to break up upon reaching certain degree of blunting and maximum wear resistance of the grain edge.

In its production, Master Technics uses the following quality of abrasive grains:

10A - regular (brown) aluminium oxide contains 95-97% Al_2O_3 and because of its high hardness and toughness it is used for grinding of metals and low alloy and non-hardened steels of medium and high resistance, especially for coarse grinding.

12A - mixture of regular and white aluminium oxide that combines the features of both and is used for grinding of heat treated steel.

21A, 22A and 23A - at heart of these qualities is white aluminium oxide that contains 99.5-99.9% Al_2O_3. It is the hardest of all corundums but it is also highly brittle. These three qualities differ in respect of bonds that are used in their production and hardness. Red bond is used in quality 21A, white in 22A, and blue in 23A. Because of its great cutting performances, it is mostly used for sharpening of tools made of super high-speed cutting steel as well as for precision grinding of heat treated and stainless steel.

30A - seminoble aluminium oxide contains about 98% Al_2O_3, and it is very hard but less brittle than white aluminium oxide. It is recommended for coarse and other grindings of low alloy heat treated steels that are sensitive to overheating.

40A - pink aluminium oxide contains about 99.5% Al_2O_3 and it is very hard but less brittle as compared to white aluminium oxide. Abrasive wheels made of pink aluminium oxide superbly "hold the edge" and are less sensitive to mechanical irregularities while grinding. Wheels of pink aluminium oxide are used for treatment of high alloy steel prior before heat treatment and, in many cases, after the heat treatment.

42A - is a mixture of white and pink aluminium oxide and as such it combines their features and it is very often used for various purposes.

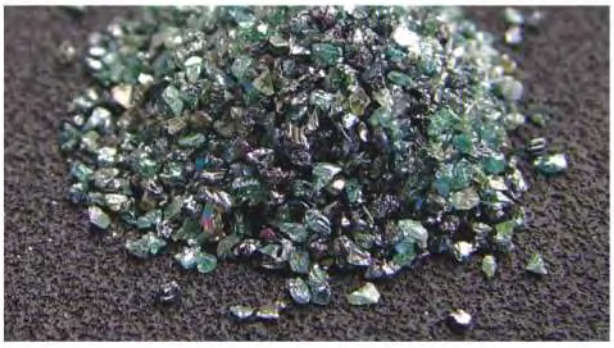
60A - ruby corundum contains about 98% Al_2O_3 and 2% Cr_2O_3 and is one of the best quality corundums. It is hard but less brittle than the white aluminium oxide. It is recommended for grinding of tools of high precision and hardness.

80A - special monocrystaline aluminium oxide contains about 99.5% Al_2O_3 and owing to the special production process it consists of grains that contain individual crystals. Grains of monocrystaline aluminium oxide are very hard and cuttable but a little bit brittle, so they are used for treatment of high-speed cutting steel and special steels sensitive to even relatively low heating.

In addition to the above stated, we also use specially modified corundums for production of abrasive wheels for special purposes.

ZK -zircon aluminium corundum contains about 54.5% Al_2O_3 and 41.5% ZrO_2 and it is extremely tough. Abrasive wheels made of this corundum are recommended for coarse grinding under high and regular operating pressure, especially for coarse grinding of steel and steel casting.

10C - green silicon carbide contains min 99% silicon carbide. Grains of silicon carbide are very hard and brittle, and thus sensitive to loading. They are used for grinding of hard metal tools, as well as for grinding of ceramic and glass surfaces. Specially made grains are used for grinding of very hard alloy and heat treated steel.



90C - black silicon carbide contains 97.5-98% silicon carbide, and is very hard but less brittle than the green one. It is used for coarse grinding of metals of low mechanical resistance, cast iron and gray cast iron, copper, bronze, aluminium, minerals, ceramics, etc.

In addition to the above mentioned, some other combinations of qualities are possible in order to obtain optimum features of abrasive wheels depending on their application.

SELECTION OF ABRASIVE GRAIN SIZE

The abrasive grain size or granulation is defined by the international FEPA standard. It is marked with numbers that refer to the number of openings on the sieve through which the relevant grain passes in the length of one inch (25,4mm) and stops on the first next sieve with smaller openings. In production we use granulations of 12 (the largest) to 360 (the smallest). According to the fineness of abrasive wheel, grains can be coarse (grains 12-24), medium (grains 30-60), fine (grains 70-220) and very fine (grains 220-360).

As a rule, abrasive wheels with coarse grains are chosen for coarse grinding of materials, and wheels with fine grains are chosen for precision grinding, however there are some exceptions to the rule so when choosing the grain size it is best to follow recommendations or consult a professional.

SELECTION OF GRINDING WHEEL HARDNESS

Hardness of grinding wheels is the force of the bond holding together the abrasive grains, i.e. the resistance that each abrasive grain shows before breaking out of the bond, i.e. wheel.It is marked by letters F-T (from very soft to very hard). The hardness depends on the bond, quality and size of the abrasive grain. It should be noted that the hardness of wheel has nothing to do with the hardness of the abrasive grain the wheel is made of, which means that soft wheel can be made out of hard abrasive grains and vice verse.

There is a rule to grind hard materials with soft wheels and soft material with hard grinding wheels, although when choosing hardness of grinding wheel some other factors should also be considered: state of the grinder, shape of parts that are being ground, features of material that is being ground, requested quality of the treated surface, so when choosing hardness of grinding wheel it is best to follow recommendations or consult a professional.

SELECTION OF GRINDING WHEEL STRUCTURE

Wheel structure is closely related to porosity which determines the percentage of bulk volume of pores in unit volume of grinding wheel. It is marked with numbers 3-18, ranging from thick to very porous wheels.

According to the shape and layout of pores, there are wheels of open and close porosity.Wheels of low porosity contain higher percentage of abrasive grains in a single unit volume than porous wheels.
For a particular number of porosities, volume percentage of grains is a constant value, whereas bond quality and porosity structure are variables, depending on the hardness of the grinding wheel. Porosity indicates vacant pores - openings in the wheel. The purpose of pores is to accommodate the sawdust while operating the wheel. Porosity and structure are closely related to hardness (bond quantity) of the wheel, so they must always be considered jointly.
Selection of grinding wheel structure is made depending on the grinding manner and material. One of the rules is to choose grinding wheels of closed structure for cylindrical grinding and wheels of open structure for surface grinding of large areas. Materials that produce a lot of sawdust while grinding, due to their physical features or materials sensitive to heat are well treated with porous wheels which only disadvantage is relatively fast wear.

SELECTION OF BOND

Master Technics produces vitrified and resinoid bonded grinding wheels.

Vitrified wheels are produced by mixing ceramic raw materials with abrasive grains. The mixture is then moulded into desirable shape and burned at the temperature of about 1300ºC. These wheels are very resistant to high temperatures present in grinding areas, resistant to technical solutions (cooling fluid) and they also have high mechanical resistance.

Resinoid wheels consist of abrasive grain and bond of modified phenolic resin. After mixing and moulding, resinoid wheels undergo heat treatment at the temperature of about 200ºC.

Resinoid grinding wheels are mostly used for coarse grinding but are also applied for some fine grindings. They are less brittle and more elastic than vitrified bonded wheels and have very high mechanical resistance because of which they are used for grinding at high peripheral speeds.

All types of armoured-reinforced grinding wheels that operate at high peripheral speeds are resinoid bonded. However, vitrified wheels are as a rule more appropriate for fine and precision grindings, because of the fact that they better "hold the edge", and are more resistant to coolants and have no expiry dates.

MARKING OF GRINDING WHEEL QUALITY AND ORDER EXAMPLE

For complete identification of abrasive product from our programme, it is necessary to state the following group of information:

- shape of abrasive tool
- dimensions of abrasive tool
- quality
- operating peripheral speed
- possible special requests in terms of manufacture

The following elements determine the quality of abrasive tool:

- kind and type of abrasive grain
- granulation of abrasive grain
- hardness
- structure
- bond

Marking of abrasive tool material is carried out in the following manner:

10A 60 M 8 V

Type of abrasive grain:

10A-regular normal aluminium oxide
11A-special normal aluminium oxide
12A-mixture of white and normal alumium oxide
21A-white aluminium oxide with red bond
22A-white aluminium oxide with white bond
23A-white aluminium oxide with blue bond
30A-seminoble aluminium oxide
40A-pink aluminium oxide
42A-mixture of white and pink aluminium oxide
60A-ruby aluminium oxide
80A-monocrystaline aluminium oxide
ZA-zirconia aluminium oxide
10C-green silicon carbide
90C-black silicon carbide

Grain size (Granulation):

12-24 - rough
30-60 - medium
70-220 - fine
240-360 - very fine

Hardness:

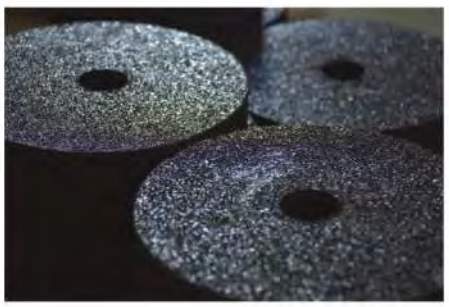
Very soft: F-G
Soft: H-K
Medium: L-O
Hard: P-S
Very hard: T

Structure:

Closed: 3
Medium: 4-6
Open: 7-10
Very porous: 11-18

Bond:

B-resinoid
V-vitrified

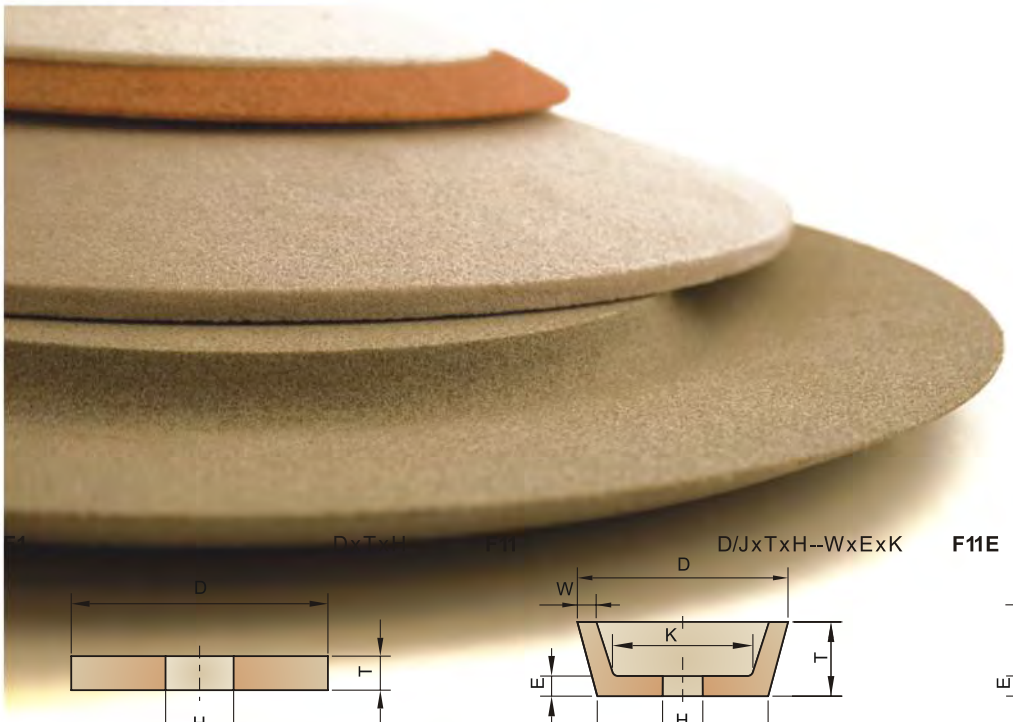


Complete order of a grinding wheel would be as follows:

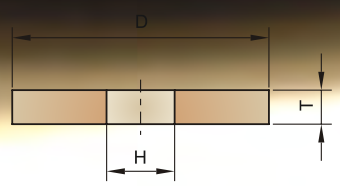
F1	200x20x20	22A60K6V	40 m/s
shape	External diameter x thickness x hole diametar	quality	Operating speed

However, if user of abrasive tool does not have all necessary information to complete the order, he/she can always consult our professionals.

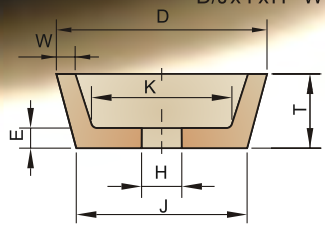
OVERVIEW OF STANDARD SHAPES



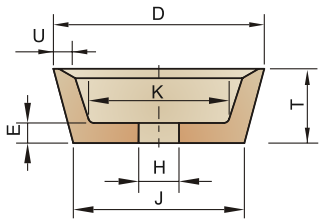
F1 DxTxH



F11 D/JxTxH--WxExK



F11E D/JxTxH--UxExK



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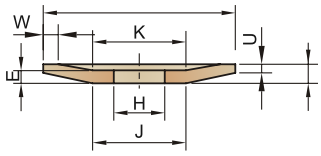
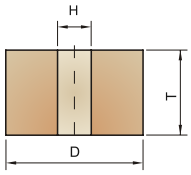
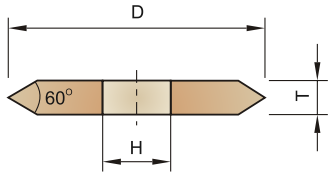


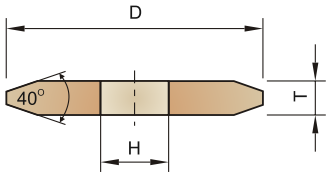
F1 DxTxH



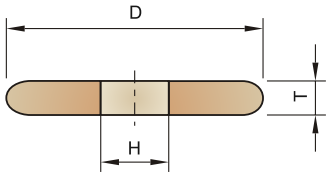
F1E DxTxH



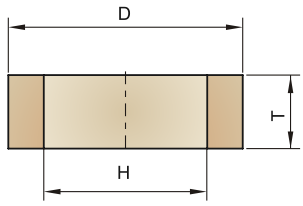
F1Esp DxTxH



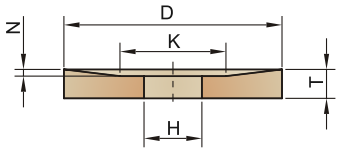
F1F DxTxH



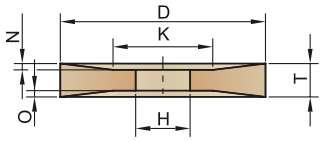
F2 DxT--W



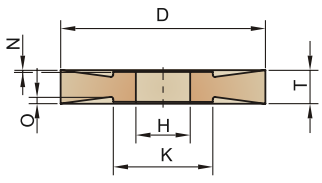
F20 D/KxT/NxH



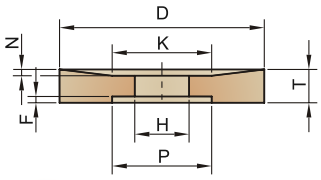
F21 D/KxT/N/OxH



F21P D/KxTxH--N/O



F22 D/KxT/NxH--PxF



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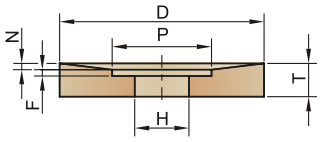
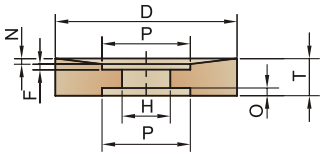


F24 DxT/NxH--PxF/O



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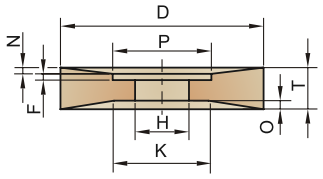
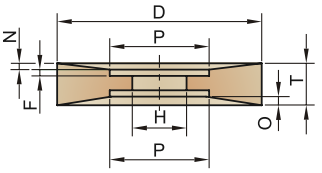
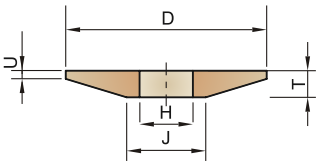


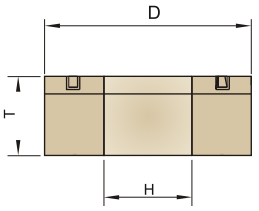
F26 DxT/N/OxH--PxF



F3 D/JxT/UxH



F37 DxTxH



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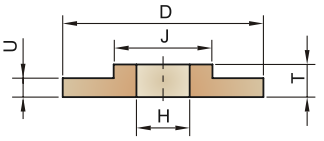

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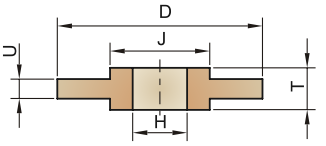
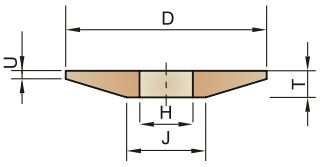
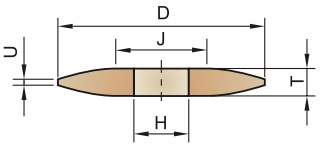


F3A D/JxT/UxH



F4 D/JxT/UxH



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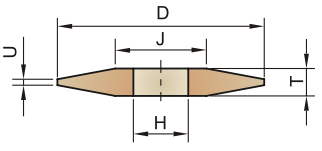
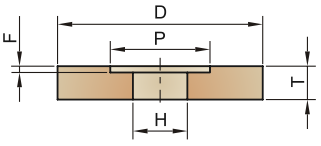


F5 DxTxH--PxF



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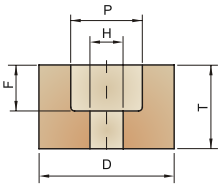
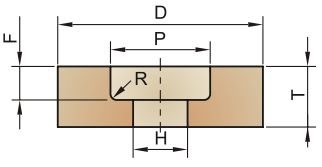
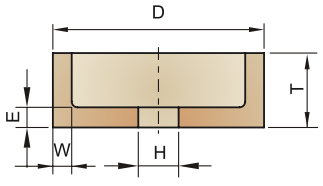


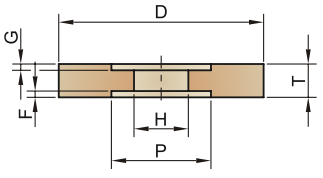
F5G DxTxH--PxF



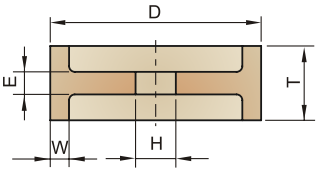
F6 DxTxH--WxE



F7 DxTxH--PxF/G



F9 DxTxH--WxE



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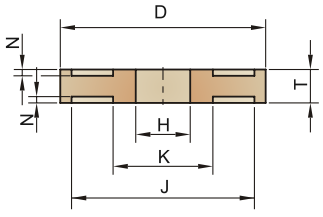
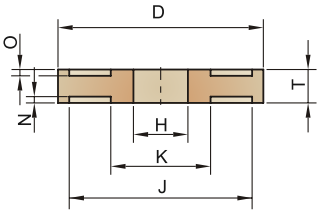
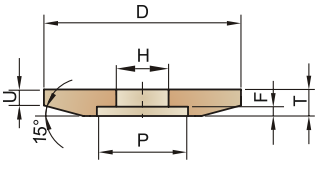


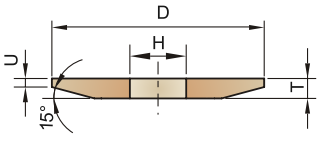
F9PF D/KxTxH--JxN/O



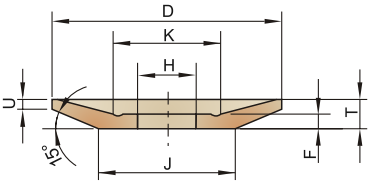
KLINGELNBERG-2 D/JxT/UxH--PxF



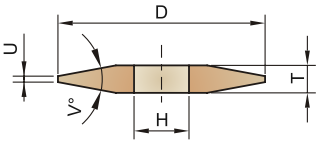
KLINGELNBERG-1 D/JxT/UxH



MAAG D/JxT/UxH--KxE

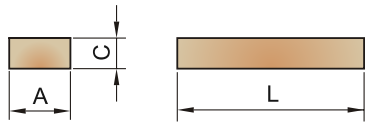


NILES DxT/UxHxV

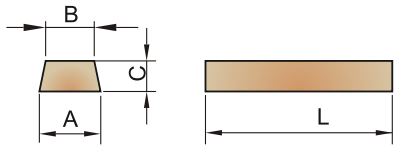


OVERVIEW OF STANDARD SHAPES

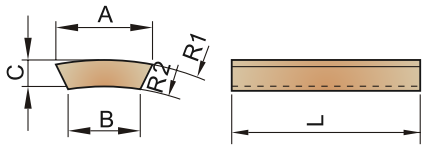
31A AxCxL



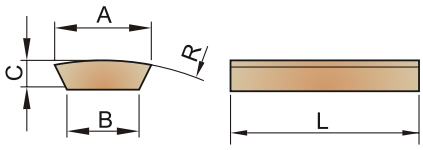
31B A/BxCxL



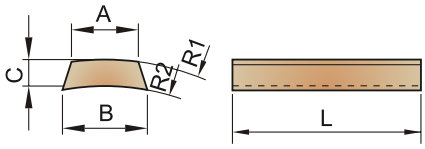
31C A/R1/R2/BxCxL



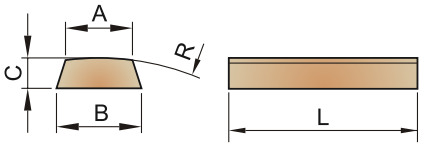
31CR A/R/BxCxL



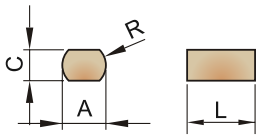
31D A/R1/R2/BxCxL



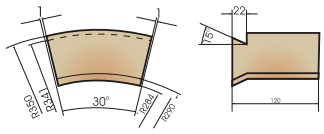
31DR A/R/BxCxL



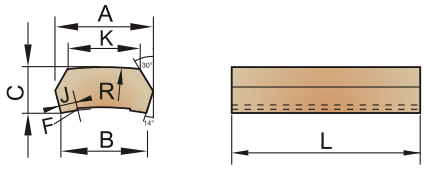
31ARR A/RxCxL



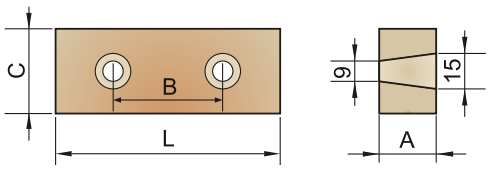
Interni standard

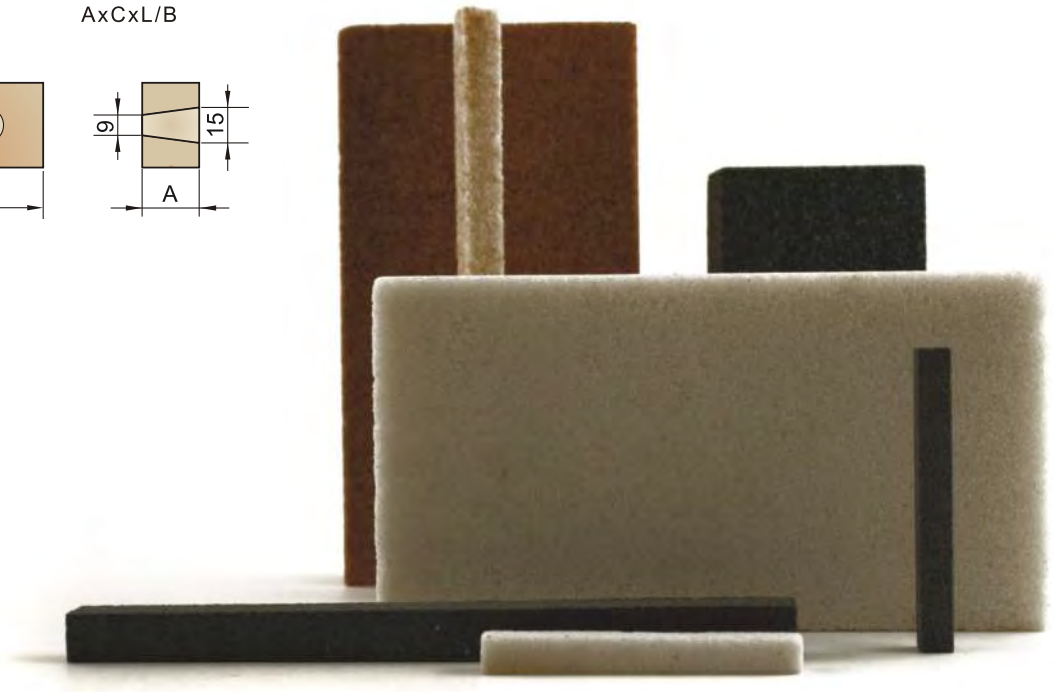


Interni standard LxAxKxC/R/B/F/J

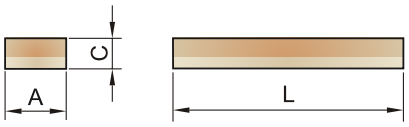


90BT AxCxL/B

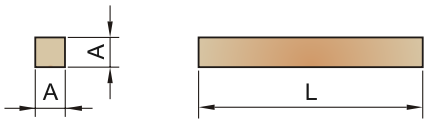




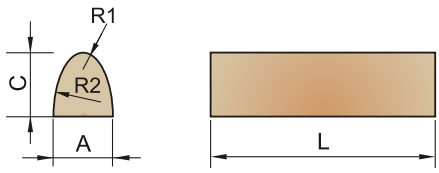
90KB AxCxL



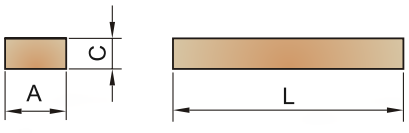
90KV AxL



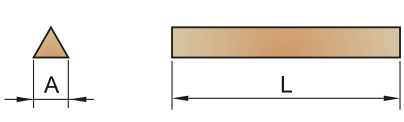
90PEL AxCxL/R1/R2



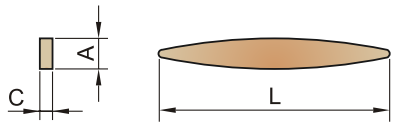
90PR AxCxL

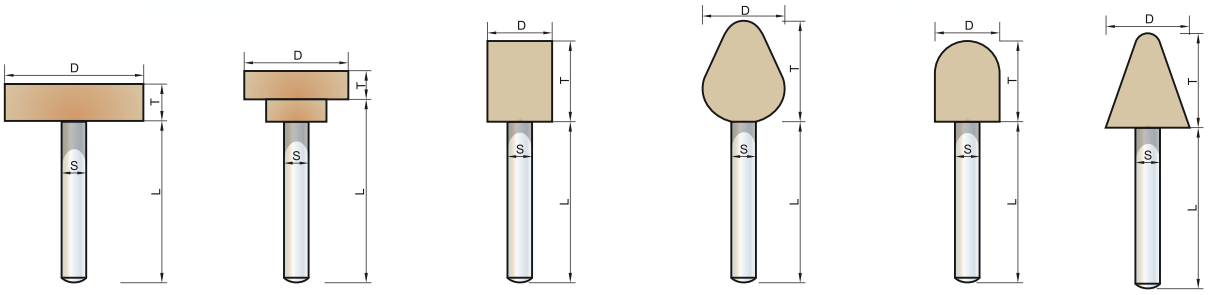


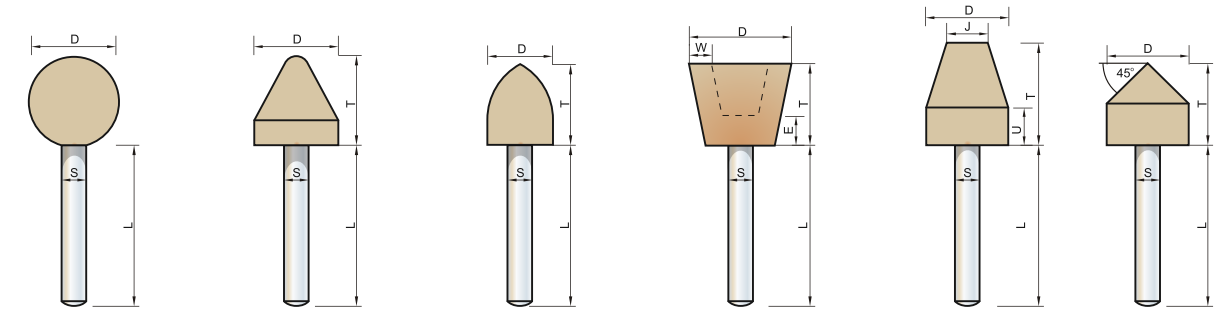
90TR AxL

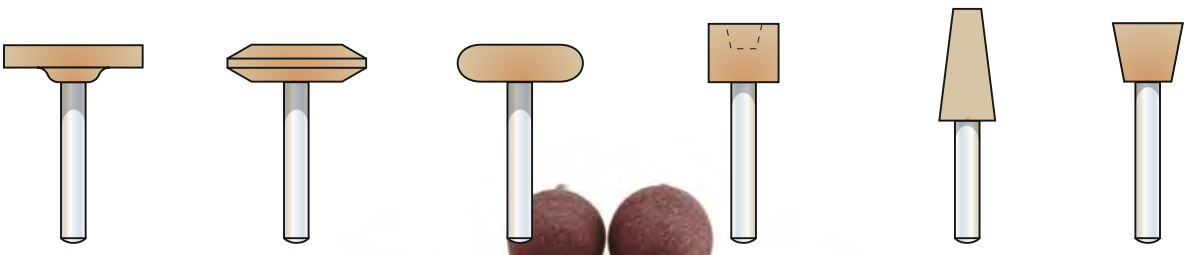


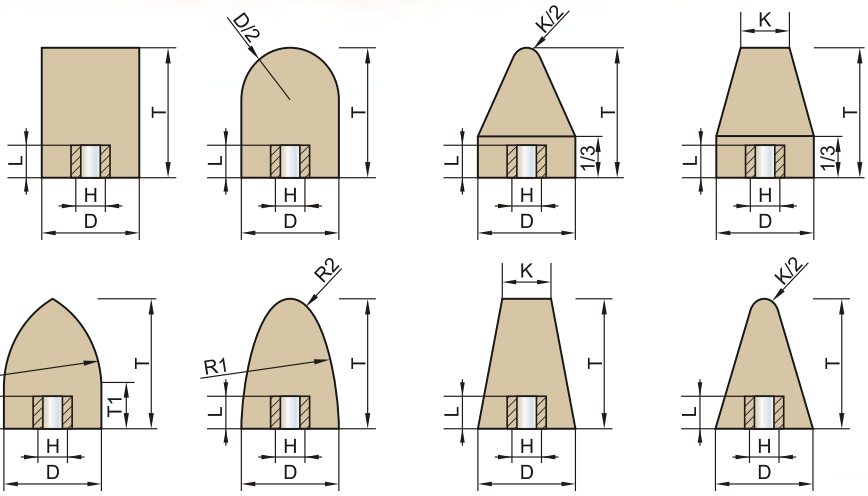
PBK AxCxL




D
T
S
L


D
T
S
L
W
E
J
U
45°



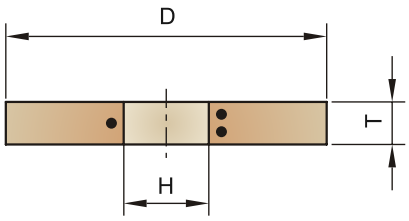

D/2
K/2
K
R
R1
R2
T
T1
L
H
D
1/3

SNAGGING ON STABLE AND SWING FRAME GRINDING MACHINES

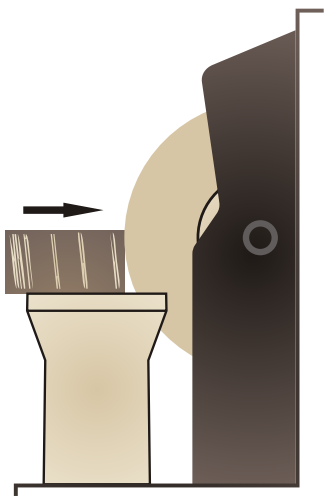
Grinding wheels for snagging on stable and swing frame grinding machines are used for coarse snagging and grinding of casts and forgings in foundries and forging works, as well as for coarse grinding of materials in other branches of metal-working industry.

These grinding wheels are mostly used at peripheral speeds of 50 and 63 m/s and in most of the cases they are resinoid bonded. Disks for peripheral speed of 50 m/s operate with steel reinforcement, whereas disks for 63m/s apart from the reinforcement also use a fine grained ring. The number of steel reinforcements depends on the thickness of disk.

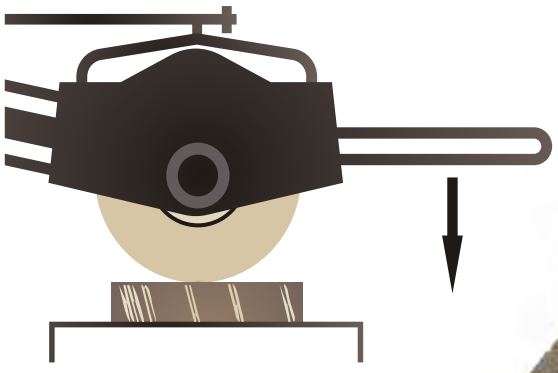
GRINDING ON STABLE GRINDING MACHINES

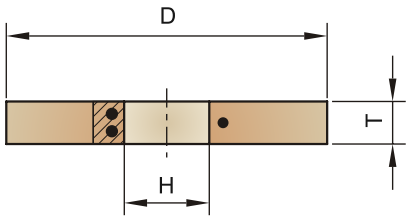


Maximum operating speed
50 m/sec



GRINDING ON SWING FRAME GRINDING MACHINES





Operating speed
50 m/sec
63 m/sec

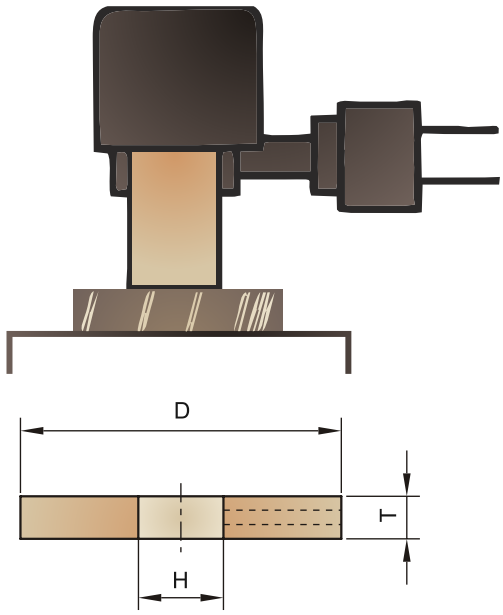
STANDARD DIMENSIONS		
D (mm)	T (mm)	H (mm)
300	max 80	30 / 32 / 35 / 50 / 76 / 127
350	max 80	30 / 32 / 35 / 50 / 76 / 127 / 203
400	max 80	40 / 127 / 150 / 200 / 250
450	max 80	50 / 127 / 150 / 152 / 203
500	max 80	45 / 50 / 127 / 150 / 200 / 203 / 305
508	max 100	406
600	max 100	60 / 200 / 203 / 305 / 400

APPLICATION		Abrasive grain	Grain size	Hardness	Structure	Bond
Steel and steel cast		10 / 12A / ZA	14 - 24	P - T	2 - 4	B
Nodular cast iron High alloy and high-speed steel		12A / ZA	16 - 24	P - S	3 - 4	B
Gray cast iron		90C / AC / 12A / ZA	14 - 24	P - S	3 - 4	B
Chilled cast iron	Before heat treatment	90C / AC	16 - 24	O - S	3 - 4	B
	After heat treatment	12A / ZA	14 - 24	O - S	4	B
Non-ferrous metals		90C	16 - 24	O - R	4	B

GRINDING WITH PORTABLE GRINDING MACHINES

Abrasive disks that are used in portable grinding machines, pneumatic or electrical, are mostly used at peripheral speeds 50-80 m/s.

For safety reasons, these disks are glass fiber reinforced.



Maximum operating speed
80 m/sec

STANDARD DIMENSIONS		
D (mm)	T (mm)	H (mm)
100	max 42	20 / 25
125	max 80	20 / 25
150	max 80	20 / 25
175	max 42	20 / 25
200	max 42	20 / 25 / 32 / 76
250	max 80	20 / 25 / 50 / 76

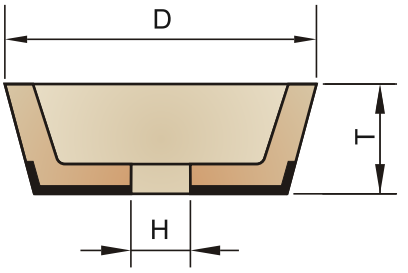
APPLICATION		Abrasive grain	Grain size	Hardness	Structure	Bond
Steel and steel cast		10 / 12A / ZA	16 - 30	P - S	2 - 4	B, BF
Nodular cast iron High alloy and high-speed steel		12A / ZA	16 - 30	P - R	3 - 4	B, BF
Gray cast iron		90C / AC / ZA	16 - 30	P - S	3 - 4	B, BF
Chilled cast iron	Before heat treatment	90C	16 - 30	P - S	3 - 4	B, BF
	After heat treatment	12A / ZA	16 - 30	O - S	3 - 4	B, BF
Non-ferrous metals		90C	16 - 30	O - R	4 -5	B, BF

In addition to the above stated recommendations in tables, these grinding wheels can also operate in specially adjusted qualities, in accordance with the client's requests.

GRINDING WITH RESIN BONDED CUP WHEELS

Cup wheels are resinoid bonded and have a sheet steel washer. They are used for grinding of stone and similar ceramic materials, and can also be used for specific grinding of steel casts, gray cast iron and other metals in which process the quality is adjusted to the purpose.

ISO – Oblik 11 F11P – DxTxH



D (mm)	T (mm)	H (mm)
110	55	22

The basic quality for production of resinoid bonded cup wheels is 90C - black silicon carbide.

Grain size and marking:

0 - 90C20L6B

1 - 90C36L6B

2 - 90C60L6B

3 - 90C120L6B

4 - 90C240L6B

Apart from the regular qualities, resin bonded cup wheels can be made in other qualities and granulations, upon client's request:

10C - green silicon carbide
22A - whitte noble aluminium oxide
12A - mixture of normal and white aluminium oxide

Resin bonded cup wheels are used for grinding in machines for special purposes or for operation of manual portable grinders.

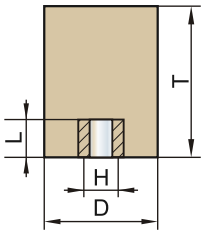
Maximum operating speed of this product is 50m/s.

GRINDING WITH CONES WITH NUTS

Nut inserted abrasive cones are used for cleaning of casts and forgings in foundries and forging plants, as well as for coarse grinding of materials in other branches of metal-working industry. They are mounted on pneumatic or electrical grinders, by appropriate winding. Nut inserted abrasive cones are produced preferably in resinoid bond and used at peripheral speeds of up to 50 m/s. Upon special request, special vitrified bonded variants which are used at peripheral speeds of up to 32 m/s can be produced.

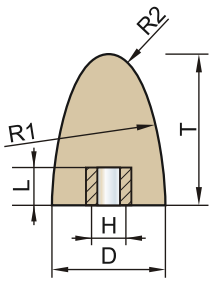
APPLICATION		Abrasive grain	Grain size	Hardness	Structure	Bond
Steel and steel cast		10 / 12A / ZA	24	P - T	2 - 4	B
Nodular cast iron High alloy and high-speed steel		12A / ZA	20 - 30	P - S	3 - 4	B
Gray cast iron		12A / 90C	20 - 30	P - S	3 - 4	B
Chilled cast iron	Before heat treatment	90C	20 - 30	O - S	3 - 4	B
	After heat treatment	12A / ZA	20 - 30	O - S	4 - 5	B
Non-ferrous metals		10C / 90C	16 - 30	M - R	4 -6	V

Shape 18 -DxTxH



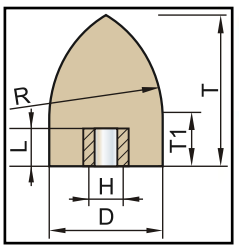
D	T	H	L
32	40	M10	16
40	40	M10 / M12	16, 20
40	63	M12	20
40	80	M12	20
80	100	M18	30

Shape 16 -DxTxH



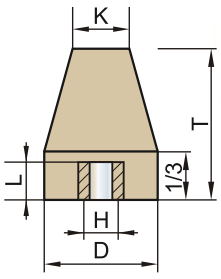
D	T	H	L	R1	R2
40	63	M12	20	190	10

Shape 15 -DxTxH



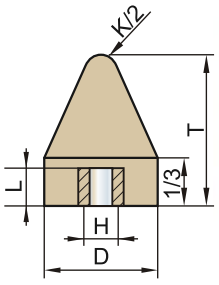
D	T	H	L	T1	R
40	63	M10,M12	20	40	32
40	80	M12	20	48	38

Shape 19 -DxTxH



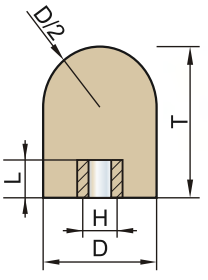
D	T	H	L	K
40	63	M12	20	10

Shape 19R -DxTxH



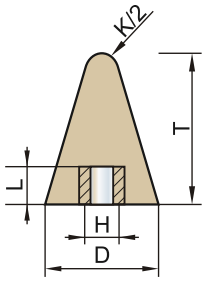
D	T	H	L	K
80	75	M18	30	20
80	100	M18	30	20

Shape 18R -DxTxH



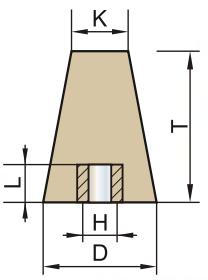
D	T	H	L
80	75	M18	30

Shape 19R -DxTxH



D	T	H	L	K
80	75	M18	30	20
80	100	M18	30	20

Shape 17R -DxTxH



D	T	H	L	K
40	63	M12	20	10

ABRASIVE WHEELS FOR ROUGH GRINDING

GRINDING WITH MOUNTED WHEELS

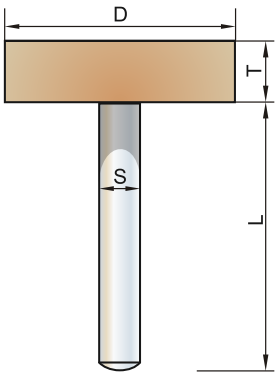
Mounted wheels with handles are vitrified and resinoid bonded and are used for various grindings of parts that cannot be treated by abrasive wheels. They are used for coarse grinding in foundries and forging plants, as well as for fine grinding in other industries.

Wheels for fine grinding are mostly produced in quality 40A60K6V, although they can be produced in all other qualities upon request.

Maximum operating speed of mounted wheels is 32m/s. These wheels are produced with bars of 6,8 and 9mm diameter.

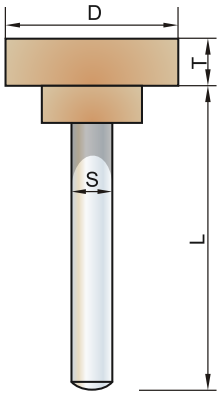
Recommendation for grinding with mounted wheels

APPLICATION	Abrasive grain	Grain size	Hardness	Structure	Bond
Universal usage	40A	36-80	K-P	4-6	V
Weld cleaning	12A	36-60	N-P	4-6	B
Steel cast	12A / ZA / 62A	20-30	P-S	4-6	B,V
Nodular cast iron	12A / ZA / 62A	20-30	P-S	4-6	B,V
Gray cast iron	10C	20-36	N-R	4-6	B,V
Non-ferrous metals	90C	20-36	N-R	4-6	V
Special steels	22A	46-60	M-P	5-6	V



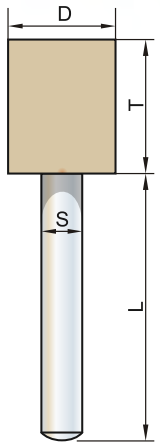
Shape 52 A-DxTxS

Designation	D	T	S	L
JUS A5	16	8	6	40
IS 23/6	20	12	6	40
JUS A9	25	12	6	40
JUS A 12 (IS 24/6)	40	10	6	40
JUS A 13 (IS 25/6)	40	20	6	40
	40	40	6	40
JUS A 14	50	12	6	40
JUS A 15	50	25	6	40



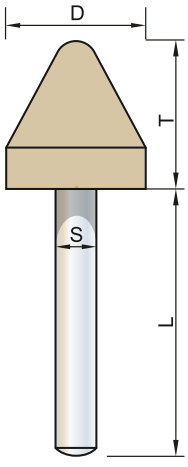
Shape 52 A 1-DxTxS

Designation	D	T	S	L
IS 20/6	15	3	6	40
JUS A4	16	4	6	40
IS 21/6	20	4	6	40
JUS A6	20	5	6	40
JUS A7	20	10	6	40
JUS A8	25	6	6	40
JUS A10	32	8	6	40
JUS A11	32	16	6	40



Shape 52 8 -DxTxS

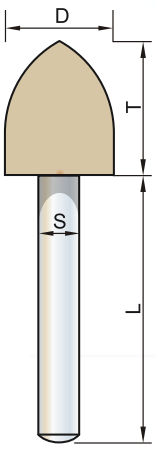
Designation	D	T	S	L
JUS B26	10	12	6	40
JUS B27	10	20	6	40
JUS B28	10	32	6	40
JUS B29	12	16	6	40
IS 7/6	12	20	6	40
JUS B30	12	25	6	40
	16	16	6	40
JUS B31	16	20	6	40
JUS B32	16	32	6	40
IS 15/6	16	40	6	40
JUS B33	16	50	6	40
	20	20	6	40
JUS B34 (IS 9/6)	20	25	6	40
	20	32	6	40
JUS B35	20	40	6	40
	25	32	6	40
JUS B36	25	32	6	40
IS 12/6	30	30	6	40
	32	30	6	40
JUS B37	32	40	6	40



Shape 52 D1 -DxTxS

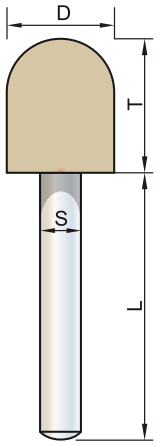
Designation	D	T	S	L
IS 26/6	20	25	6	40
IS 13/6	30	30	6	40

ABRASIVE WHEELS FOR ROUGH GRINDING



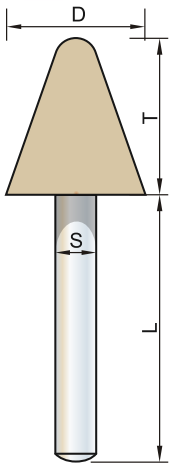
Shape 52 E -DxTxS

Designation	D	T	S	L
JUS E63(IS 8/6)	12	20	6	40
JUS E64	20	32	6	40



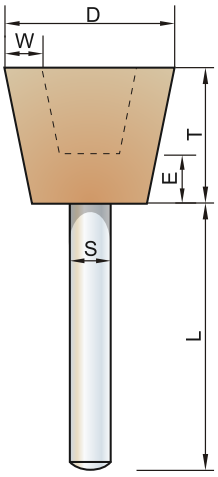
Shape 52 C -DxTxS

Designation	D	T	S	L
JUS C43	12	20	6	40
JUS C44 (IS 10/6)	20	25	6	40



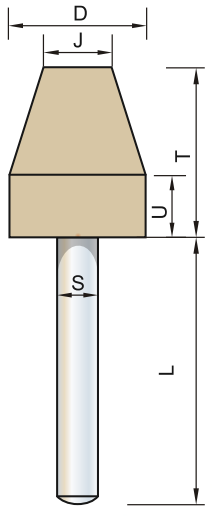
Shape 52 D -DxTxS

Designation	D	T	S	L
JUS D50	10	10	6	40
JUS D51	12	12	6	40
JUS D52	16	16	6	40
JUS D53	20	20	6	40
JUS D54	25	25	6	40
JUS D55	32	32	6	40



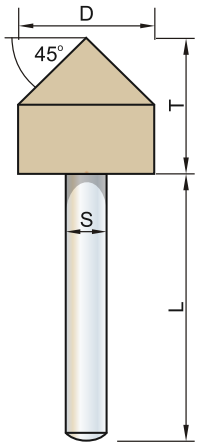
Shape 52 F -DxTxS

Designation	D	T	S	L	W	E
JUS F70	20	16	6	40	4	5
JUS F71	25	20	6	40	5	7
JUS F72	32	25	6	40	6	9



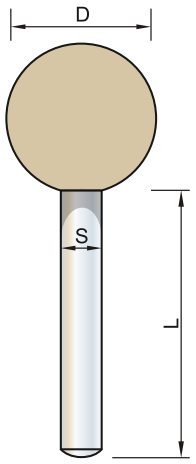
Shape 52 G -DxTxS

Designation	D	T	S	L	J	U
JUS G80	12	20	6	40	0	9
JUS G81	20	25	6	40	6	13
JUS G82	25	32	6	40	10	19
JUS G83	32	40	6	40	14	24
JUS G84	12	25	6	40	0	19



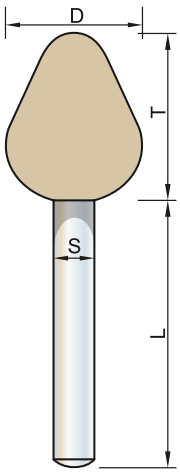
Shape 52 I -DxTxS

Designation	D	T	S	L
IS 19/6	20	20	6	40



Shape 52 H -DxTxS

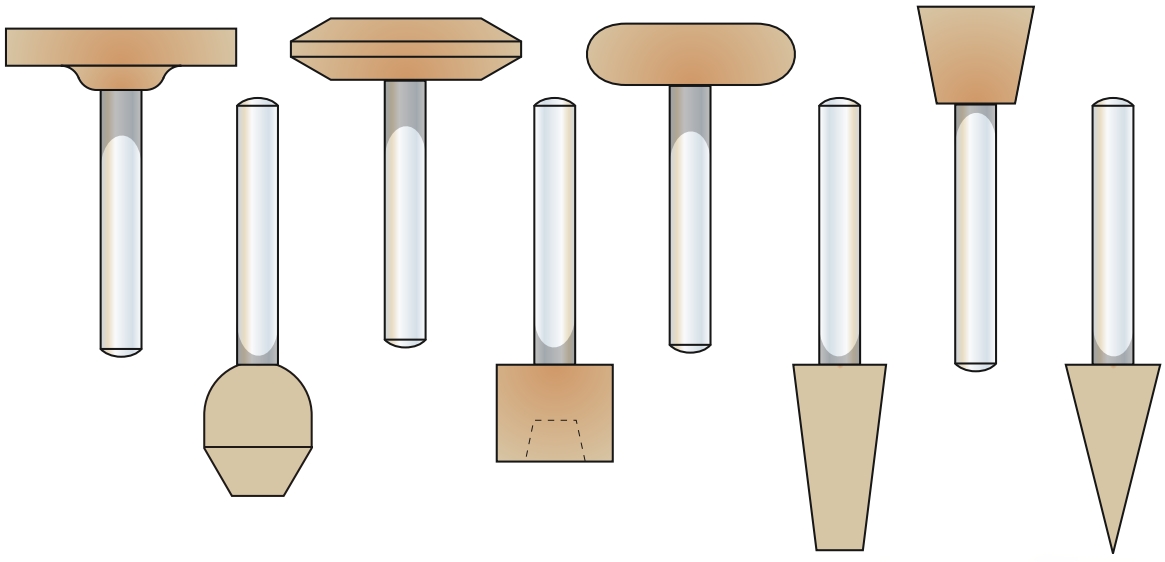
Designation	D	S	L
IS 17/6	15	6	40
JUS H94	20	6	40
IS 18/6	30	6	40
JUS H95	25	6	40
JUS H96	32	6	40



Shape 52 N -DxTxS

Designation	D	T	S	L
IS 11/6	20	25	6	40

Apart from the stated forms, some other profiles can be produced upon request of the customer. Also, in addition to the bar s=6mm, certain abrasive profiles can be manufactured with bars s=8mm and s=9mm

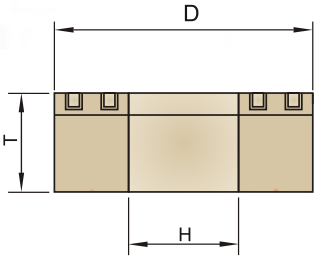


GRINDING TOOLS WITH NUTS

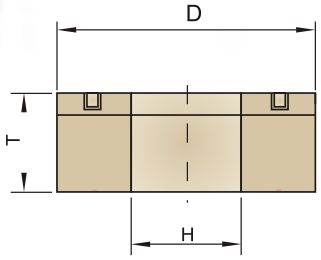
Abrasive wheels bound to the girder by nuts are a special category of wheels for coarse grinding and rarely for precision grinding. This category has various purposes and shapes.

Shapes of grinding wheels with nuts:

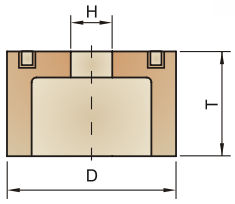
F37 DxTxH



F36 DxTxH



F6 DxTxH



Abrasive wheels with nuts are very often used for two wheel side grinding.

Table - dimensions of grinding wheels with nuts

D	T	H	Binding
400	Max 60	250	Nuts or gluing
508	Max 110	406	Nuts
600	Max 100	400	Nuts or gluing

Qualities used for this purpose are covered in the category of coarse grinding on stable and swing frame grinding machines.

A subgroup of these abrasive wheels are grinding wheels for spring grinding. In some cases these wheels can be glued to a metal surface instead of being bound by nuts.

Table - Recommendations for selection of grinding wheel quality for spring grinding

Type of spring	Grain	Granulation	Hardness	Bond
Thick wire springs	12A	16-20	P-S	B,V
Medium wire springs	12A, 40A	20-30	O-Q	B,V
Thin wire springs	12A, 22A,40A	30-60	M-P	V,B

Nuts can also be used for binding of abrasive cups or rings used for face surface grinding, which are covered in a separate chapter.

This category also includes wheels used for cleaning of welded joints of rail tracks, to serve the needs of railway.

F6 DxTxH

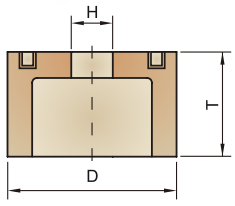


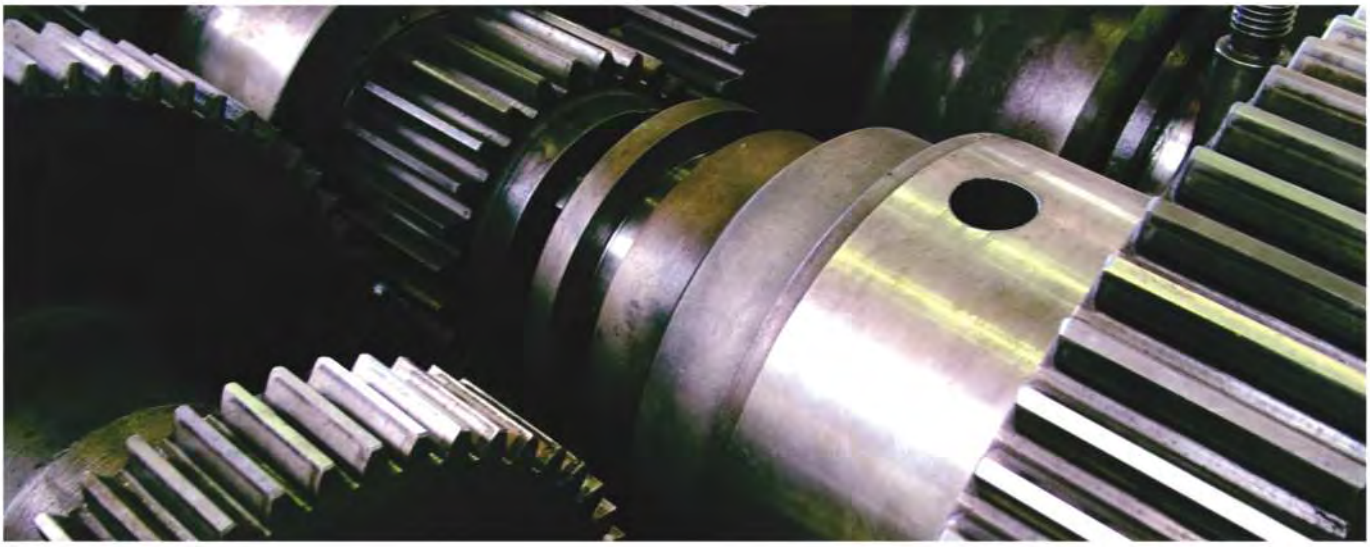
Table - dimensions of wheels for cleaning of welded joints of rail tracks

D	T	H	Nut	Number of nut
125	60	55	M8	4
150	60	80	M8	6

Quality 12A(14-20)S4B

The same category also includes grinding cones with nuts, which are covered in a separate chapter.

Nuts M8, M10, M12, M16, M18 and M20 are used in our production.



PRECISION GRINDING

Precision grinding implies more demanding grinding in terms of accuracy of dimensions and quality of treated surface.

It can be roughly divided into the following categories:

- external cylindrical grinding
- surface grinding
- internal circular grinding
- tool sharpening
- gear grinding
- thread grinding
- honing

D (mm)	T (mm)	H (mm)
70	Max 15	18
80	Max 50	20 / 25
85	Max 20	19
100	Max 50	20 / 25
125	Max 80	20 / 25
150	Max 80	20 / 25 / 76
175	Max 50	20 / 25 / 32
200	Max 100	20 / 25 / 32 / 50-51 / 76 / 160
225	Max 50	20 / 25 / 40 / 50-51
250	Max 100	20 / 25 / 51 / 76
300	Max 100	30 / 32 / 35 / 50 / 76 / 127
350	Max 100	30 / 32 / 35 / 50 / 76 / 127 / 203
400	Max 100	40 / 127 / 150 / 200 / 250
450	Max 100	50 / 127 / 150 / 152 / 203
500	Max 100	45 / 50 / 127 / 150 / 200 / 203 / 305
600	Max 100	60 / 200 / 203 / 305 / 400
900	Max 100	305 / 355

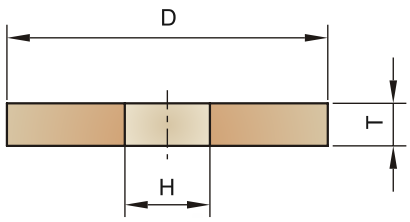
TABLE 1 - Dimensions of precision grinding wheels

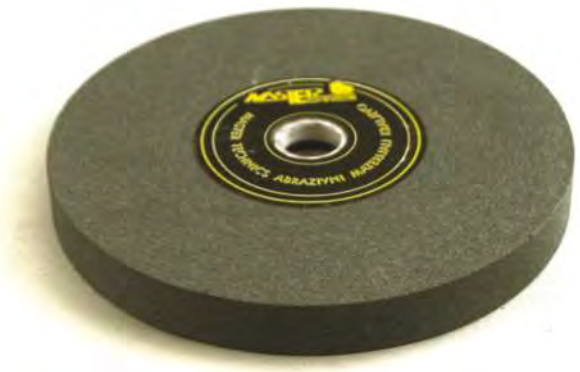
EXTERNAL CYLINDRICAL GRINDING

External cylindrical grinding includes circular cylindrical and centerless grinding.
Vitrified abrasive wheels that operate at peripheral speed 16-40 m/s are used for cylindrical grinding. Wide scope of abrasive wheels belong to this category in terms of dimensions, choice of material that is being ground and grinding quality. A separate subgroup in this category are abrasive wheels for grinding of spindles, as well as vitrified and resinoid wheels for grinding of rollers, which operating speed is up to 50 m/s.

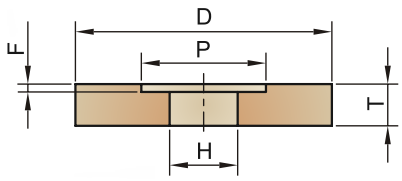
Vitrified and resinoid bonded wheels that operate at peripheral speed 32-50 m/s are used for centerless grinding. Since these wheels are of great thickness, our abilities are for now limited to maximum thickness of 100 mm, although in some cases it is possible to combine 2 or more abrasive wheels of the same or compatible quality, thus compensating for the required thickness.

F1 DxTxH

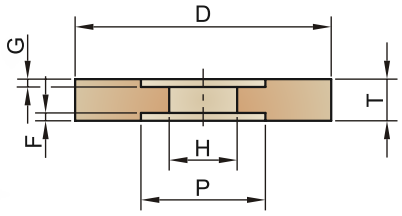




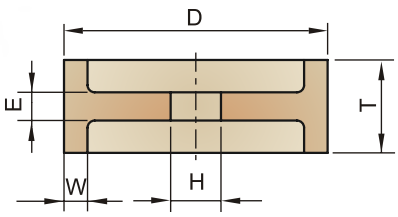
F5 DxTxH--PxF



F7 DxTxH--PxF/G



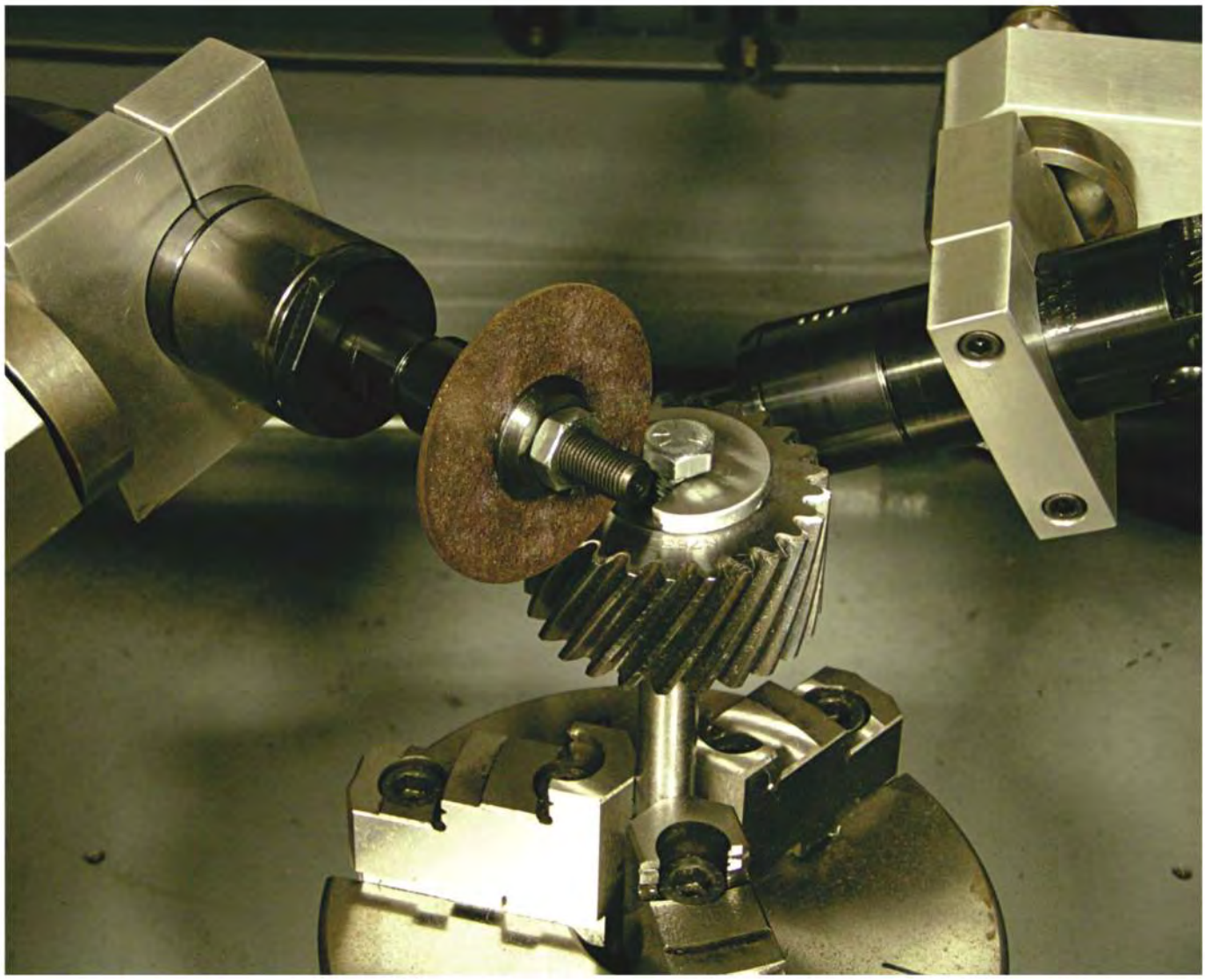
F9 DxTxH--WxE



ABRASIVE WHEELS FOR PRECISION GRINDING

Recommendations for use of abrasive wheels for external circular grinding:

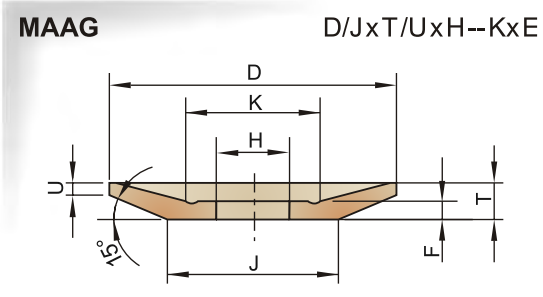
Application		Abrasive grain	Grain size	Hardness	Structure	Bond
Unhardened steels Undeclared steels		10A,11A,12A,30A	36-80	K-P	5-8	V
Hardened steels	<55 HRC	12A,21A,22A,40A	36-80	H-L	6-8	V
	56-62 HRC	40A,42A,60A	46-80	H-L	6-9	V
	62-64 HRC	60A,80A	46-80	H-L	6-12	V
	>64 HRC	80A,84A,10C	46-80	H-K	8-12	V
Hard chrome plated steel		40A,80A	46-120	I-J	8-10	V
Tool steel	high alloy	60A,80A	46-80	H-J	6-8	V
	stainless	80A,10C	46-80	I-J	7-9	V
	high-speed	22A,42A,80A	46-80	G-J	7-8	V
Unhardened stainless steels		22A,80A	46-80	K	6-12	V
Hardened stainless steels		60A,80A,10C	46-80	J-K	6-12	V
Nitrated steels		10C	54-100	J-K	6-8	V
Non-ferrous metals, plastics		10C,90C	24-60	H-J	5-7	V
Rubber		10C,84A	36-60	H-J	10-12	V
Gray cast iron		12A,90C	46-60	K-L	7-8	V
Rollers		22A,10C,80A,90C	24-220	J-L	4-14	B-V
Carbide alloys		10C	60-100	H-K	7-8	V



GEAR GRINDING

The following abrasive wheels are used for gear grinding:

Plate-shaped abrasive "MAAG"

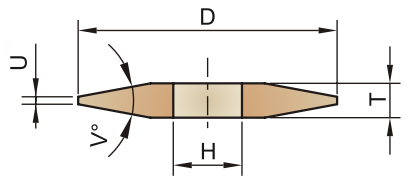


D	T	H	U	E	J	K	L
220	18	40	2	16	120	140	105(80)
220	18	40	3	16	120	140	105(80)
220	18	40	4	16	120	140	105(80)
220	18	40	6	16	120	140	105(80)
280	25	40	4	18	120	140	105(80)
280	25	40	8	18	120	140	105(80)
340	25	40	4	18	120	140	105
340	25	40	8	18	120	140	105

ABRASIVE WHEELS FOR PRECISION GRINDING

Double-sided tapered disk "NILES"

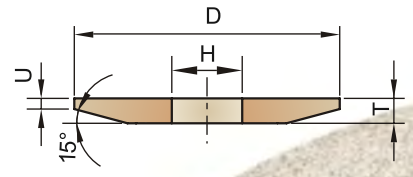
NILES DxT/UxHxV



D	T	H	U	V
250	13	51	3	30° (40°)
250	16	51	4	30° (40°)
250	20	51	4	30° (40°)
300	25	90	4	30° (40°)
350	32	90	5	30° (40°)

Single-sided tapered disk "KLINGELNBERG"

KLINGELNBERG-1 D/JxT/UxH



D	T	H	U	I
250	14	32	3	110

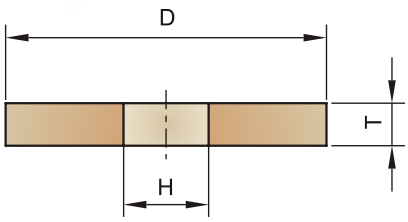
Application	Abrasive grain	Grain size	Hardness	Structure	Bond
Heat treatable steel	22A, 40A	46-100	J-K	6-8	V
Tool and hardened steels	22A, 40A	46-100	H-K	6-8	V
Centation steel	22A	46-100	I-K	6-9	V
Nitrated steels	10C	60-100	J-K	6-10	V
Gray cast iron	22A	46-100	J-K	6-8	V
Undeclared steel before heat treatment	12A	54-100	J-K	6-9	V

In addition to the dimensions and shapes stated in the tables we also produce other dimensions and shapes upon request of our clients.

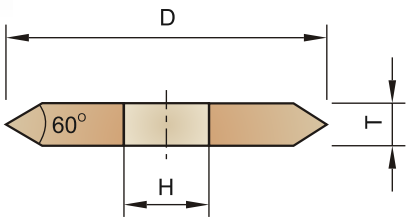
THREAD GRINDING

As regards thread grinding wheels, we produce unprofile and single profile grinding wheels in all qualities and granulations up to 220.

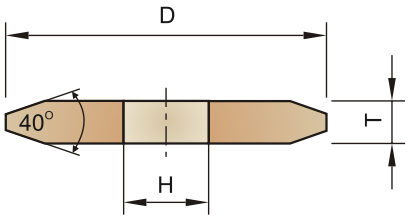
F1 DxTxH



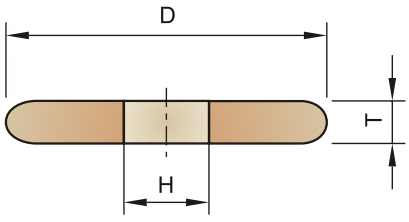
F1E DxTxH



F1Esp DxTxH



F1F DxTxH



Thread grinding wheels are produced according to the dimensions given in TABLE 1 (page 28)

All thread grinding wheels are produced as straight grinding wheels of F1 shape, whereas the profiling is done by the user, with the exception of single profile grinding wheels for which we can do the profiling upon user's request.

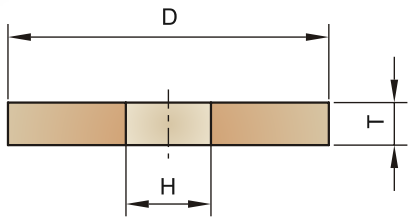
Recommendations for thread grinding wheels

Application	Abrasive grain	Grain size	Hardness	Structure	Bond
Structural steel	22A, 80A	120-220	J-L	7-12	V
Tool and high-speed steels	10C, 80A	120-220	G-L	5-12	V

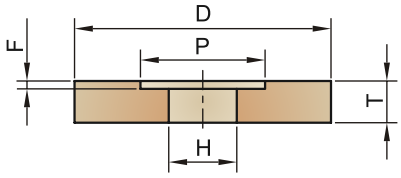
TOOL SHARPENING

The following shapes are used for sharpening of hand tools, turning tools and drills:

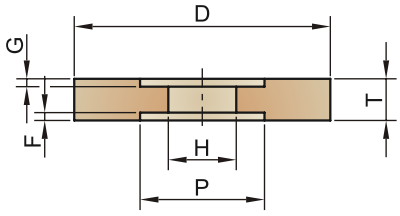
F1 DxTxH



F5 DxTxH--PxF

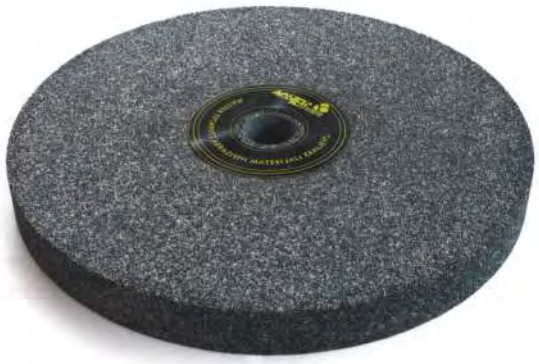


F7 DxTxH--PxF/G



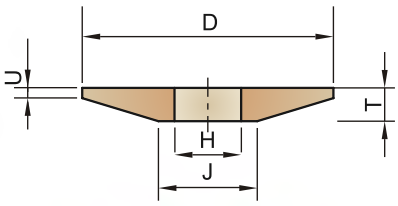
Maximum allowed peripheral speed is 40 m/s.

Dimensions of these grinding wheels are given in TABLE 1 (page 28)



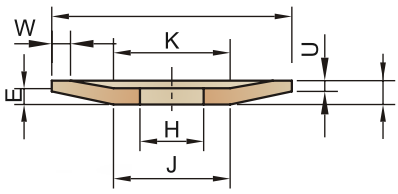
The following shapes are used for sharpening of milling and boring tools:

F3 D/JxT/UxH



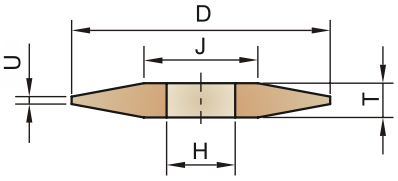
designation	D	T	H	U	I
A80	80	5	20	1	30
A100	100	6	20	1,5	50
Al25	125	7	20	2	68
A150	150	8	20	2	82
A175	175	10	20	3	95
A200	200	12	32(20)	3	95
A250	250	14	32	3	125

F12 D/JxT/UxH--WxExK



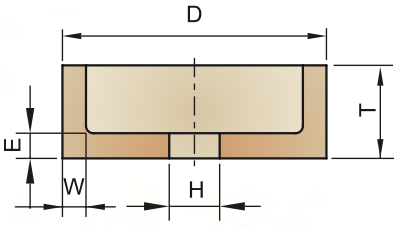
designation	D	T	H	L(W)	U	E	J=K
B80	80	8	20	72(4)	2	6	30
B100	100	12	20	88(6)	3	8	35
B125	125	14	20	113(6)	3	9	40
B150	150	15	20	136(7)	3	10	50
B175	175	18	20	159(8)	3	11	60
B200	200	19	32(20)	180(10)	3	12	70

F4 D/JxT/UxH



designation	D	T	H	U	V
C80	80	8	20	2	15°
C100	100	9	20	2	15°
C125	125	10	20	2	15°
C150	150	12	20	2	15°
C175	175	14	20	3	15°
C200	200	16	32	3	15°
C250	250	19	32	4	15°

F6 DxTxH--WxE



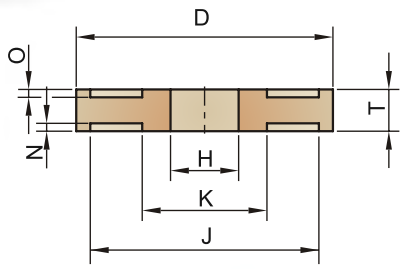
designation	D	T	H	W	E	R
D80	80	40	20	4	8	4
D100	100	50	20; 51	5; 10	10	4
D125	125	63	20	7,5	12	5
D150	150	80	20	10	16	5

Maximum operating speed of these grinding wheels is 32 m/s.

ABRASIVE WHEELS FOR PRECISION GRINDING

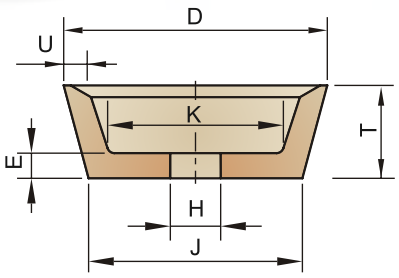
designation	D	T	H	K	J	N	O
F100/6	100	6	20	50	94	-	1.5
F100/10	100	10	20	50	94	1.5	3
F150/6	150	6	20	70	144	-	1.5
F150/10	150	10	20	70	144	1.5	3
F150/15	150	15	20	70	144	2.5	4.5
F175/20	175	20	32(20)	70	167	3	6
F175/25	175	25	32(20)	70	163	4.5	7.5
F200/20	200	20	32(20)	95	192	3	6
F200/25	200	25	32(20)	95	188	4.5	7.5

F9PF D/KxTxH--JxN/C



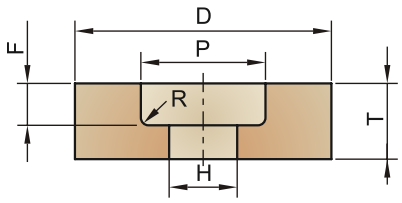
designation	D	T	H	E	J	K
E 80	80	32	20	8	55	48
E100	100	35	20	10	75	65
E125	125	45	20	12	92	80
E150	150	50	20(32)	12	114	100

F11E D/JxTxH--UxExK



designation	D	T	H	P	F	R
G150	150	32	20	80	20	5
G175	175	32	32(51)	90	20	5
G200	200	40	32(51)	110	25	5
G225	225	40	51	135	25	5
G250	250	40	51(76)	150	25	6
G300	300	50	76(127)	180	30	6
G350	350	63	127	210	41	6

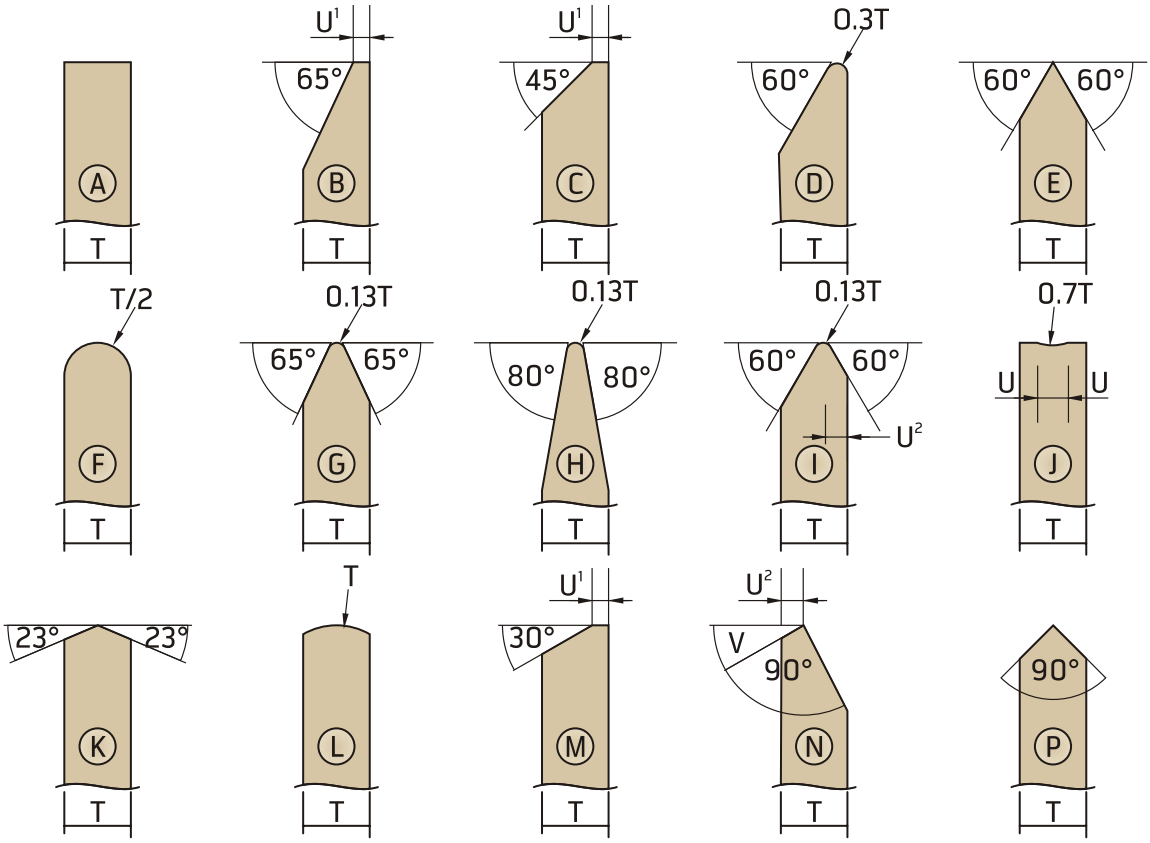
F5G DxTxH--PxF



Application		Abrasive grain	Grain size	Hardness	Structure	Bond
Steels	Unhardened	10A,12A,40A	46-80	K-M	6-8	V
	Tool	21A, 22A, 40A, 42A, 60A	46-80	G-L	6-12	V
	High-speed	22A, 42A, 80A, 82A	46-100	I-L	6-8	V
Hard metals metal carbides (masonry)		10C, 90C	46-120	J-K	6-7	V

GRINDING WHEELS FOR SAW SHARPENING

Grinding wheels for saw sharpening can be straight or edge profiled. Standard profiles of saw sharpening wheels are:



U^1=T/4 (ili max 3mm); U^2=T/3

Apart from the above stated, upon request we produce grinding wheels with various rims. Grinding wheels for saw sharpening are mostly produced in the following dimensions:

D (mm)	T (mm)	H (mm)
150	4-10	20, 25
175	4-10	20, 25
200	4-12	20, 25, 32
250	4-12	20, 25, 32
300	6-14	20, 25, 32

These grinding wheels are used at peripheral speed of up to 40 m/s.

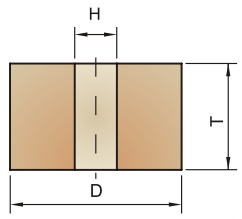
Recommendations for use of grinding wheels for saw sharpening:

Application	Abrasive grain	Grain size	Hardness	Structure	Bond
Manual saw sharpening	10A, 12A	46-80	K-M	5-6	V
Automatic sharpening	21A,22A,40A 22A/40A (dvoslojne)	46-80	K-M	5-7	V

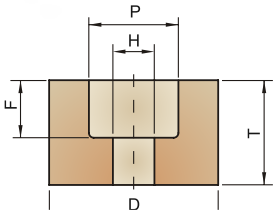
ABRASIVE WHEELS FOR INTERNAL CIRCULAR GRINDING

Shapes F1 and F5 are used for internal circular grinding

F1 DxTxH



F5 DxTxH--PxF



These grinding wheels operate at peripheral speeds from 16m/s to 40 m/s.

Dimensions of grinding wheels for internal circular grinding, shape F1:

D (diameter)	T (height)															H (opening)
	6	10	13	14	16	18	20	25	32	35	36	40	45	50	60	
10		X		X												4
13			X													4
16	X	X														6
19									X							8.5
20								X								8
25	X	X			X			X					X			10
												X	X			12.7
32										X						10
36											X					10.5
								X								12.7
												X				13
40								X				X				10.5
	X	X			X		X	X		X						13
45												X				20
50		X										X		X		10
55						X										22.5
60												X		X	X	20

Dimensions of grinding wheels for internal circular grinding, shape F5:

D	T										H	P	F
	10	16	20	25	35	40	45	50	60	80			
13		X									4	8	4
14		X									6	10	6
16	X										6	10	5
		X	X										6
20			X								6	12	8
32				X							10	16 18	12
					X								15
						X							15
40				X							13	20 22	10
						X	X	X					20
								X					34
45						X					16	28	15
								X			20	30	34
50						X					16	28	15
60								X	X		20	30	20
80								X		X	25(20)	48	18
100				X							40	60	10

In addition to the stated dimensions, upon request of the client some other dimensions can be produced

Recommendations for use of grinding wheels for internal circular grinding:

Application		Abrasive grain	Grain size	Hardness	Structure	Bond
Unhardened steels		12A, 40A	46-80	J-L	6-8	V
Hardened steels		22A, 40A, 60A	46-80	G-K	6-8	V
Hard chrome plated steels		10C, 80A	46-80	G-K	6-8	V
High - speed steels		22A, 42A, 80A	46-80	G-I	6-8	V
Steels for nitriding	Non-nitrated	21A, 22A	46-60	K-L	5-6	V
	Nitrated	10C	60-80	I-K	6-8	V
Steel cast		40A	46-60	K-L	5-6	V
Gray cast iron		10C, 90C	46-60	K-L	5-6	V
Hard brass		10C, 90C	36-60	K	5-6	V
Aluminium and non-ferrous metals		10C, 90C	36-60	G-J	5-6	V

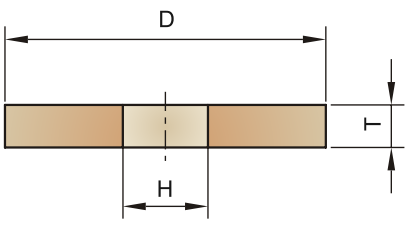
SURFACE GRINDING

Surface grinding includes peripheral surface grinding, frontal surface grinding and segment grinding.

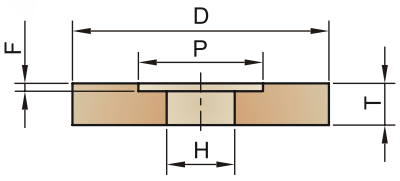
PERIPHERAL SURFACE GRINDING

For peripheral surface grinding the following grinding wheels are used: F1, F5 and F7, dimensions of which are given in the TABLE 1 (page 28).

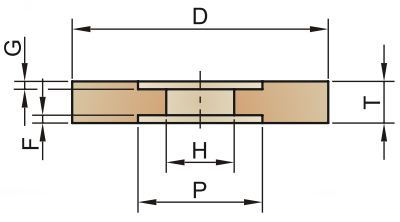
F1 DxTxH



F5 DxTxH--PxF



F7 DxTxH--PxF/G

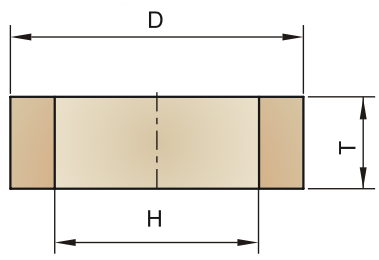


FRONTAL SURFACE GRINDING

Grinding rings, cups and segments are used for frontal grinding.

GRINDING RING

F2 DxT--W



F37 DxTxH

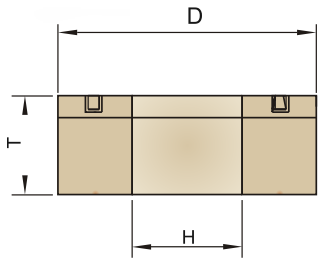


TABLE 2 - dimensions of grinding rings

D mm	T mm	H mm
200	Max 100	160
250	Max 100	200
400	Max 100	250
600	Max 100	400

GRINDING CUP

F6 DxTxH--WxE

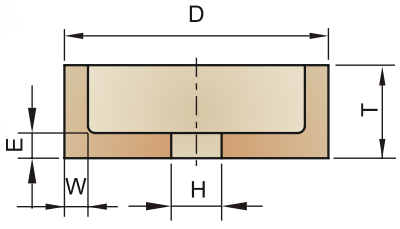
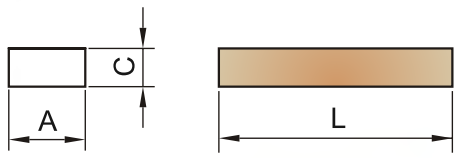


TABLE 3 - dimensions of grinding cups

D	T	H	W	E
175	Max 100	25, 76	16	20
200	Max 100	50	20	18
250	Max 100	25, 76, 127	25	17-23

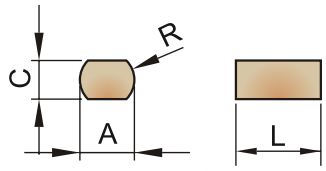
GRINDING SEGMENTS

31A AxCxL



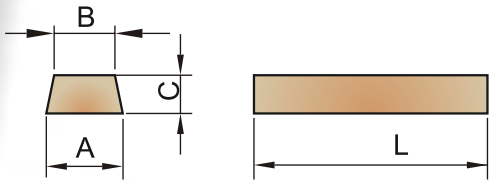
A	C	L
40	16	170
50	16	78
50	25	150
60	25	150
80	20	150
80	25	100
80	25	150
80	25	200
90	20	200
90	35	150
90	35	200
114	40	180
120	40	180

31ARR A/RxCxL



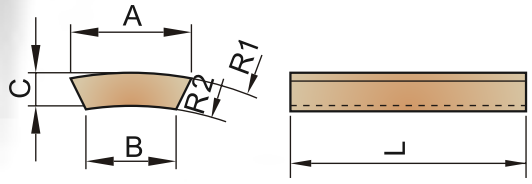
A	R	C	L
85	50	56	64

31B A/BxCxL



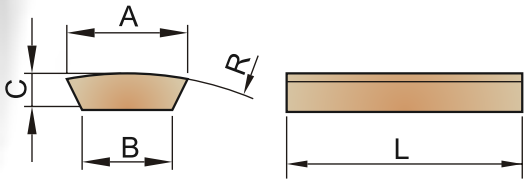
A	B	C	L
54	60	22	110
85	100	35	150

31C A/R1/R2/BxCxL



A	R1	R2	B	C	L
95	165	140	72	25	120

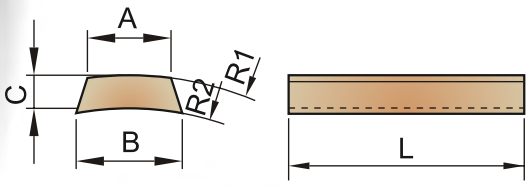
31CR A/R/BxCxL



A	R	B	C	L
67	100	31	25	150
105	139	65	35	150
85	140	59	25.7	150

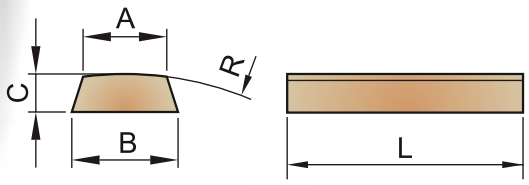
Grinding wheels for surface grinding are used at peripheral speeds of up to 32 m/s

31D A/R1/R2/BxCxL



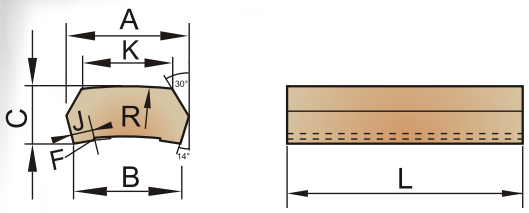
A	R1	R2	B	C	L
45	90	90	50	16	90
50	90	90	45	16	90

31DR A/R/BxCxL

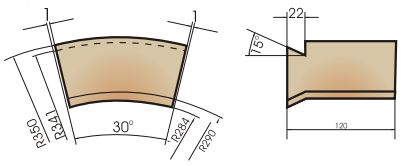


A	R	B	C	L
57.3	179	65	25	110
57.3	179	65	25	160

Interni standard LxAxKxC/R/B/F/J



A	R	K	B	C	L	F	J
119	320	86	105	55	210	15	20



Recommendations for use of surface grinding wheels:

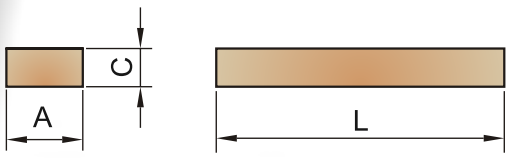
Application		Abrasive grain	Grain size	Hardness	Structure	Bond
Unhardened steel		12A	24-36	J-K	6	V
Hardened steel	<55HRC	21A, 22A, 42A	30-46	E-I	8-12	V
	55-62 HRC	40A, 42A, 60A				
	>62HRC	60A, 80A				
Tool steel	High alloy	60A, 80A	36-46	E-I	8-12	V
	High-speed	22A, 42A	36-54	E-H	6-8	V
	Stainless	22A, 80A,10C	36-60	F-J	8-12	V
					5-6	V
Gray cast iron		10C, 90C	24-46	H-K	5-6	V
Aluminium , non-ferrous metals		10C, 90C	24-36	H-J	5-6	V
Hard chrome plated steel		22A, 82A, 80A, 10C	46-80	F-I	10-14	V
				G-I	5-6	V
Ceramics, plastics		90C	16-54	K-S	3-4	B

HONING

Honing stones are actually abrasive sticks that are used for machining of internal cylinder bores and round pipes.

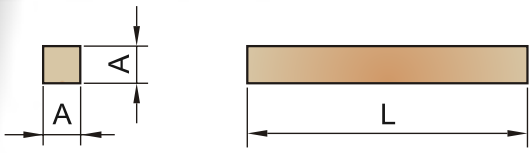
They are produced in various dimensions, shapes and qualities in granulation of up to 360 according to the FEPA standard. As a rule, honing of steel parts is done with sticks made of corrundum, whereas honing of gray cast iron is carried out with files made of silicon carbide.

90PR AxCxL



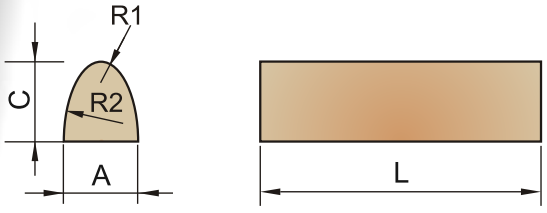
A	C	L
12	6	150
12	10	150
50	25	150

90KV AxL



A	L
7	63
10	100
12	150
20	200

90PEL AxCxL/R1/R2



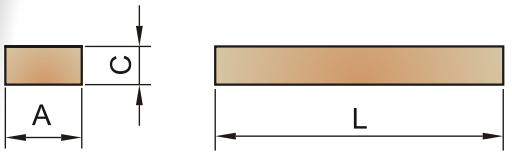
A	C	L	R1	R2
71.5	60	140	25	72

Application	Abrasive grain	Grain size	Hardness	Structure	Bond
Unhardened steels	12A, 22A	60-360	E-J	8-14	V
Hardened steels	22A, 60A, 80A	70-360	E-J	8-14	V
Gray cast iron	10C, 90C	70-360	E-J	8-14	V

ABRASIVE STRICKS AND HONE STONES

Rectangular abrasive stick and stone

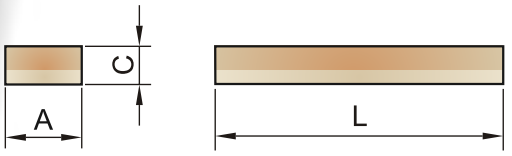
90PR AxCxL



A	C	L
12	6	150
50	25	150

Combined abrasive stone

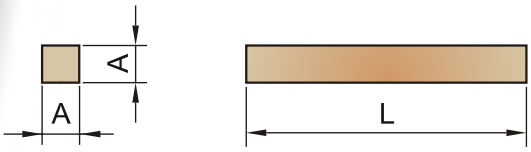
90KB AxCxL



A	C	L
50	25	150

Square abrasive stick

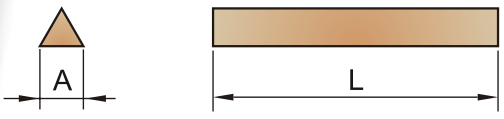
90KV AxL



A	L
7	63
10	100
12	150
20	200

Triangular abrasive stick

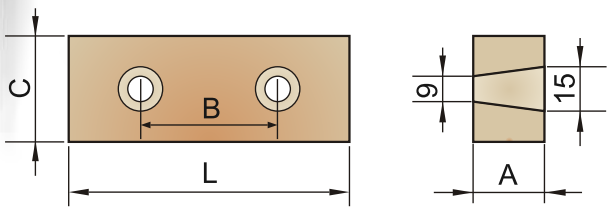
90TR AxL



A	L
10	100
10	150

Abrasive file

90BT AxCxL/B



A	C	B	L
20	40	110	170
20	40	110	180

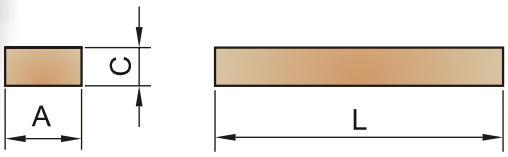
Abrasive grain	Grain size
22A, 40A, 10C, 90C	60-360

DRESSING TOOLS FOR GRINDING WHEELS

Dressing tools are used for cleaning and levelling of grinding wheels that are loaded with sawdust while operating or that have lost the required geometry. Diamant is mostly used for this purpose in precision grinding, whereas dressing tools made of classic abrasive materials are much more economical and adequate for coarse grindings and fine grindings in certain cases.

Dressing tool

90PR AxCxL



A	C	L
50	25	150

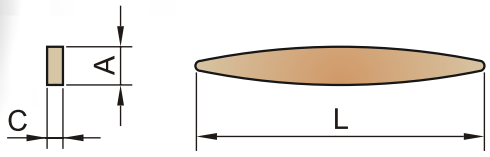
Dressing tools are made in quality

Abrasive grain	Granulation	Hardness	Porosity	Bond
10C 90C	16-24	P-S	6-12	B V

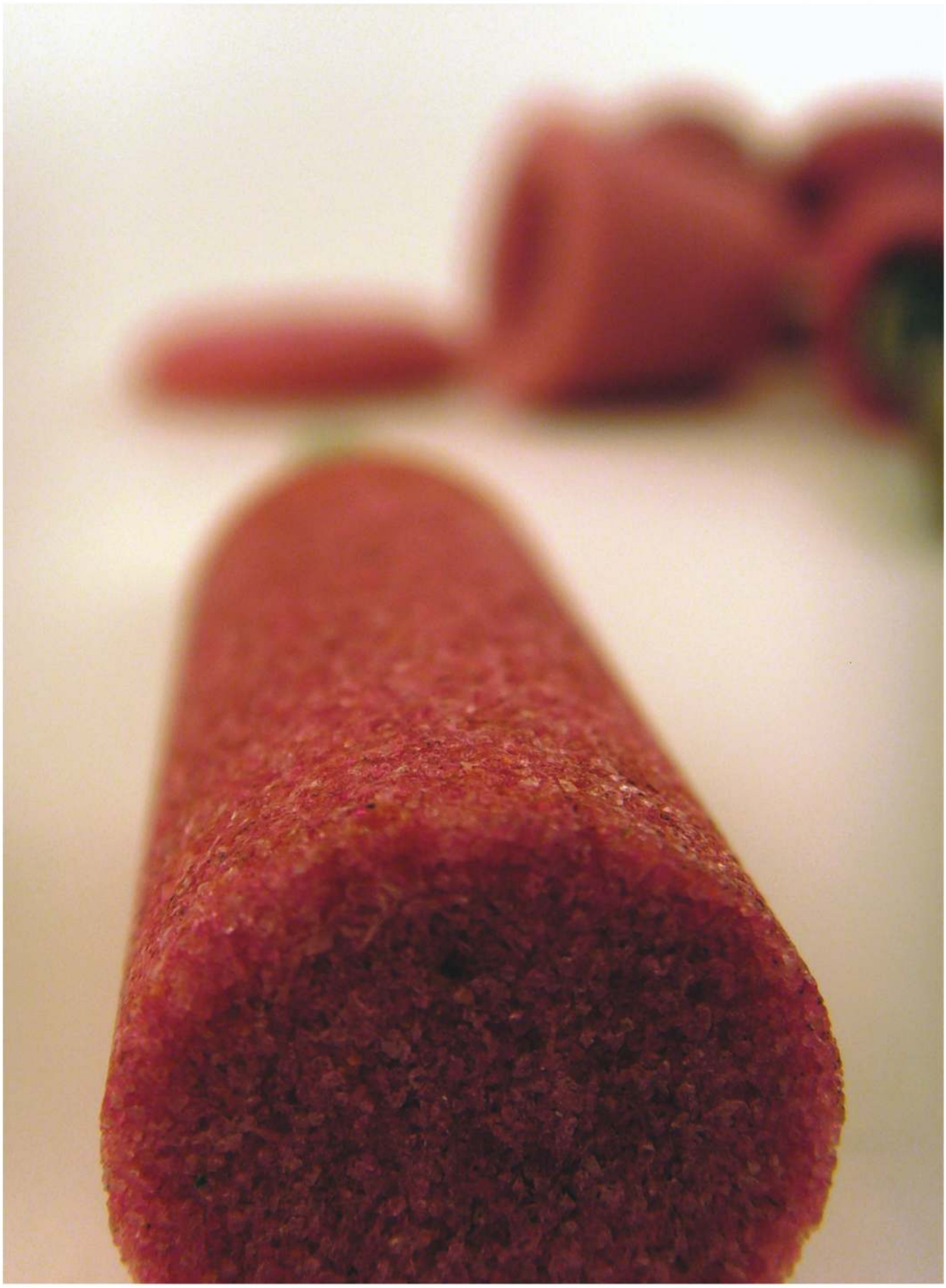
ABRASIVES FOR AGRICULTURE

Abrasives for sharpening of mowers

PBK AxCxL



A	C	L
35	13	230



MARKING OF GRINDING WHEELS AND QUALITY CONTROL

It is necessary the grinding wheel to have a label that at the same time represents a grade certificate. The label contains the basic data in terms of:

- shape
- quality
- operating speed
- production and expiry date

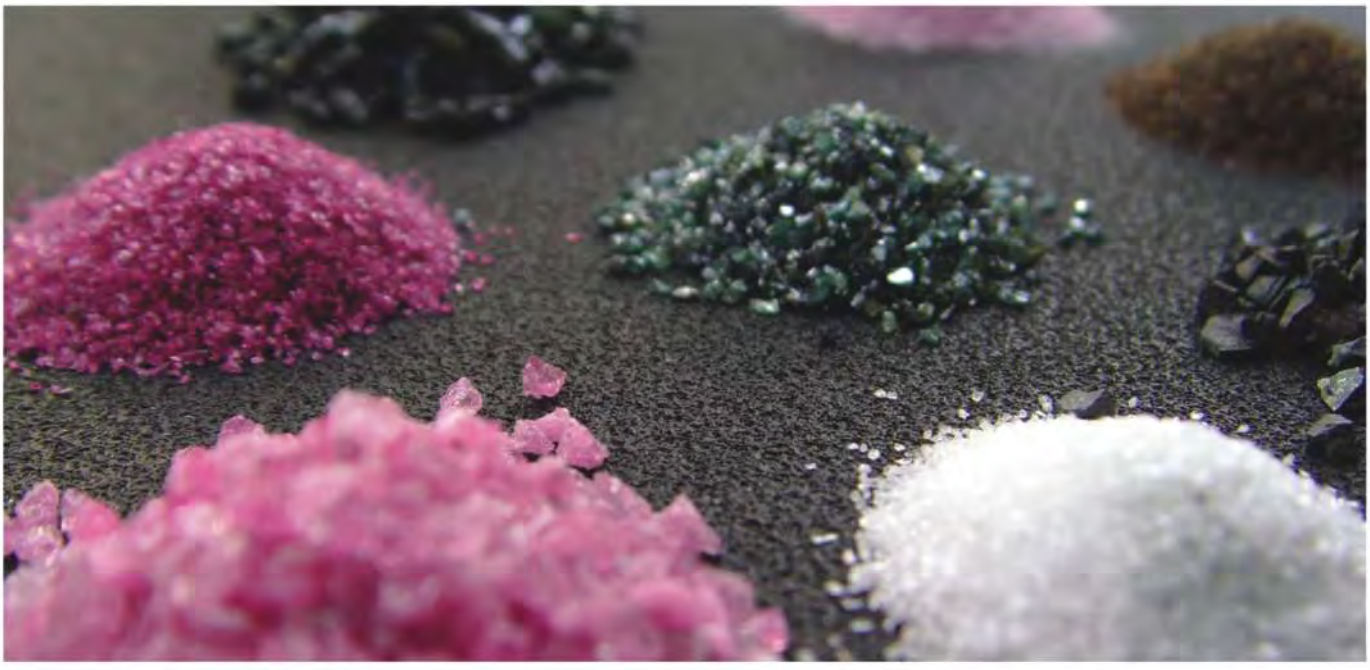
All parameters are denoted pursuant to the K.F1 standard. The catalogue provides side by side shapes that refer to comparision between JUS standard and the relevant ISO standard.

Manufacturer performs the control of grinding wheels per each and every element stated on the quality label:

- Abrasive grain type
- Abrasive grain granulation
- Grinding wheel class (hardness)
- Structure and porosity of grinding wheel
- Type of bond
- Internal denotation that in each individual case has a precisely defined meaning.

The type of abrasive grain for production of our grinding wheels is denoted according to JUS standard K.F1.005

Granulation of abrasive grain si denoted according to FEPA standard
Hardness of grinding wheel (class) is denoted by letters in ascending order from F to T. It is determined according to the internal method, since the method is not standardized.



Apart from the stated parameters on the quality label, the manufacturer also controls:

- dimensions and geometry
- imbalance
- grinding wheel safety is controlled by a test at increased peripheral speed and/or a test of speed increasing until destruction.

Geometry and dimensions of grinding wheels are controlled according to JUS standard K.F1.006

Imbalance is controlled according to JUS standard K.F1.007

Grinding wheel safety is controlled according to JUS standard K.F1.008

Prior to the above mentioned check-ups, visual control of grinding wheels is performed, as well as ring check. Both check-ups serve, first of all, to reveal cracks or other defects, if any. Grinding wheels that have no visible or latent cracks produce clear sound, whereas a dull sound implies defects onto the grinding wheel. In order to perform the test, the wheel has to be suspended and tapped with a wooden hammer or a similar object.
In addition to the label that is obligatory, denotations of dimensions and quality and maxiumum allowed operation speeds can be found on the grinding wheel itself, where:

50 m/s - marked with blue line across the diameter
63 m/s - marked with yellow line across the diameter
80 m/s - marked with red line across the diameter

Grinding wheels are packed in cartons and each grinding wheel has a label that represents a grade certificate. Master Technics shall not be liable for any damages during transport and storing at the client's premises.

At no stage should grinding wheels be knocked or dropped.

GENERAL CONDITIONS FOR SELECTION OF GRINDING WHEEL

When choosing a grinding wheel, the following elements should be considered:

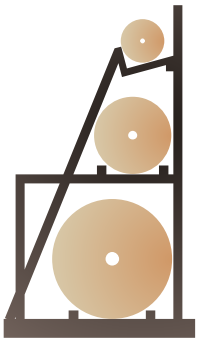
1. Wheels for coarse grinding are more efficient at removal of material, but the quality of treated surface is bad. Wheels with medium and fine size of particles of corrundum and silicon carbide are recommended for fine and precision grinding.
2. Coarse grinding and cleaning are considered to be dry grindings, whereas for fine grindings cooling fluid is used in most of the cases, so such grindings are wet grindings.
3. A general rule might be to use harder grinding wheels for softer steels and softer wheels for hard steels. Such recommendation is just for orientation purposes because there are many exceptions and specific qualities that are provided in the separate part.
4. For coarse grinding, as well as for higher peripheral speeds resinoid wheels are used, whereas for precision grinding vitrified wheels are mostly used.
5. Resinoid grinding wheels have an expiry date because the bond gradually wears, while vitrified bonded grinding wheels do not have an expiry date.
6. Resinoid grinding wheels are mostly used for dry grindings, whereas cooling fluid is often used for vitrified bonded grinding wheels. In some cases cooling fluid is used for resinoid bonded wheels, but that must be specially stated in the request.

QUALITY OF THE TREATED SURFACE - ROUGHNESS

In addition to the request for as efficient as possible removal of material in the grinding process, the second but not less important request is the quality of the treated surface, that is, roughness. Without going into technical parameters of roughness, it can be generally said that roughness is affected by the fineness and the type of abrasive grain, their disposition and grinding wheel structure, as well as the material that is being ground, the grinding method and other parameters related to the features of grinding machine. Generally speaking, grinding wheels with rough abrasive grain result in higher roughness, whereas fine grains result in better quality of the treated surface. Grinding performace is inversely proportional.

STORING, MOUNTING AND HANDLING OF GRINDING WHEEL

Grinding wheels are stored in dry premises at optimum temperature of 10-30ºC, whereas the temperature for resinoid wheels must not fall below 0ºC. Relative humidity in the premises where resinoid bonded grinding wheels are stored must not exceed 75%. Sudden temperature changes and closeness to heat source have adverse effect. Special attention should be paid to the possible exposure of vitrified wheels to impacts, especially because of their vulnerability, so they should be placed far enough from the transport lanes. The best method of adequate storage of wheels is to place them in storage-racks, according to the given scheme.



Before mounting a trained worker should carry out visual control of the grinding wheel, as well as ring test in the same manner as the manufacturer. Thus he checks whether some damages have occurred during transport or storing. It is necessary to check the expiry date of resinoid bonded grinding wheels. Qualified and trained worker should mount the grinding wheel on the grinder.
When mounting a grinding wheel, flange must be cleaned and concurrence of even sides of flange checked, clean pads must be set, made of paper or some other elastic material which thickness is 0.3-0.8mm. Also, it should be checked whether the minimum gap between the internal opening and the spindle is within the tolerance limits (H=11, 12, 13). It is not allowed to mount grinding wheels by use of force and under pressure because wheels warm up while running and additional voltage is produced that may cause the wheel to fly apart.

In addition to mounting of grinding wheel on a spindle and binding it with flanges, abrasive elements can be bound and mounted in some other ways:

- grinding disks, grinding rings and profiles with nuts are bound with bolts to the metal surface or girder. When tightening bolts, clamping force must be sufficient to hold the wheel firmly but it must not be too high to endanger the wheel safety and disrupt the nuts. According to the present experience of various manufacturers, that force must not exceed 27 N/m.
- grinding disks and rings for surface grinding can be glued to metal washers where the best alternative is the tool to be glued and controlled by us, i.e. by the manufacturer.
- Binding can also be done by clamping of segments into a specially designed grinder head, in accordance with the shape of the segment.
- In addition to bolts binding, grinding profiles can also be fastened by clamping in cartridge case of steel bars - girders of grinding profiles with diameters 6, 8 and 9mm.

Before operating a grinding wheel, the following procedure must be observed:

- the maximum operating speed of the wheel should be adjusted. The speed must not exceed the maximum declared operating speed and the worker must operate in a safe work area.
- Let the wheel run for 5 min without load
- Beginning of grinding should be gradual to enable gradual warming up of the wheel.
- If the grinding wheel has not been used for a long time, it should be operated according to the procedure for handling a new wheel.
- Before mounting and after that, expiry dates of resinoid bonded grinding wheels should be taken into consideration.

When mounting and handling a grinding wheel, a special attention should be paid to work safety. All wheels, with few exceptions, that have a special mounting procedure must have a protective hood. Also, personal protection equipment is obligatory: goggles, leather apron, glove, and in some cases helmet is mandatory. Special attention must be paid to machines that have variable number of revolutions in order for their maximum operating speed to remain within the declared limits.

Vitrified wheels use cooling fluid. In some cases resinoid wheels use cooling fluid and it has to be pointed out so that a resinoid bond that is more resistant to humidity is used. Regardless of the bond, when the grinding wheel stops running it must be centrifuged well and released of remaining humidity. Otherwise, great imbalance and possible breakdown may occur when rerunning the wheel. Residual water in resinoid bonded grinding wheels can cause additional decomposition of bond which doubles the risk when rerunning the wheel.

After certain period of operation, the grinding wheel can lose its regular geometric shape or pores can become loaded which results in decrease of grinding efficiency. In both cases it is necessary to level the grinding wheel with a diamant or dressing tool made of silicon carbide. In some cases coarse grinding wheels are dressing and sharpened with toothed metal reels. Modern machines for precision grinding have a built-in dressing system.

PERIPHERAL SPEEDS

Peripheral speed expressed in m/s directly correlate with the number of wheel revolutions of the machine (min-1) and wheel diameter. It is a parameter that must be specially observed because of the work safety and grinding quality.
Maximum allowed peripheral speed is marked on the label, as well as the maxiumum number of revolutions of the relevant wheel.
Although there are some exceptions, the following peripheral speeds are generally applied:

- max 40 m/s is applied for vitrified bonded grinding wheels for peripheral grinding, shapes F1, F3, F4, F5, F7, F20, F21, F22, F23, F24, F25, F26, F38, F39, as well as for grinding profiles with nut and handle;
- max 32 m/s is applied for vitrified wheels for side grinding, shapes: F2, F6, F9, F11, F12, F35, F36, F37, as well as for grinding segments;
- max 40m/s is applied for side grinding with straight resinoid grinding rings and segments, as well as with resinoid wheels that are bound with nuts and burned on metal surface and which are used for side grinding;
- max 63 m/s is applied for wheels that are mostly used for coarse peripheral grinding and snagging, where steel reinforcement and fine-grained ring are mandatory.
- max 80 m/s is applied for grinding wheels reinforced with glass fibre network which are used for peripheral grinding on pneumatic and electrical grinders.

TABLE OF PERIPHERAL SPEEDS

D (mm)	v (m/s)													
	15	16	20	25	30	32	35	40	45	50	60	63	80	100
	n (rpm)													
25	11500	12200	15300	19100	22900	24400	24700	30600	34400	38200	45800	48100	61100	76400
32	8950	9550	11900	14900	17900	19100	20900	23900	26900	29800	38500	37600	47700	59700
40	7160	7640	9550	11900	14300	15300	16700	19100	21500	23900	28600	30100	38200	47700
50	5730	6110	7640	9550	11500	12200	13400	15300	17200	19100	22900	24100	30600	38200
63	4550	4850	6060	7580	9100	9700	10600	12100	13600	15200	18200	19100	24300	30300
80	3580	3820	4770	5970	7160	7640	8360	9550	10700	11900	14300	15000	19100	23900
100	2860	3060	3820	4770	5730	6110	6680	7640	8590	9550	11500	12000	15300	19100
125	2290	2440	3060	3820	4580	4890	5350	6110	6880	7640	9170	9630	12200	15300
150	1910	2040	2550	3180	3820	4070	4460	5090	5730	6370	7640	8020	10200	12700
175	1640	1750	2180	2730	3270	3490	3820	4370	4910	5460	6550	6880	8730	10900
180	1590	1700	2120	2650	3180	3400	3710	4240	4770	5310	6370	6680	8490	10600
200	1430	1530	1910	2390	2860	3060	3340	3820	4300	4770	5730	6020	7640	9550
225	1270	1360	1700	2120	2550	2720	2970	3400	3820	4240	5090	5350	6790	8490
230	1250	1330	1660	2080	2490	2660	2910	3320	3740	4150	4980	5230	6640	8300
250	1150	1220	1530	1910	2290	2440	2670	3060	3400	3820	4580	4810	6110	7640
300	955	1020	1270	1590	1910	2040	2230	2550	2860	3180	3820	4010	5030	6370
350	819	873	1090	1360	1640	1750	1910	2180	2460	2730	3270	3440	4370	5460
400	716	764	955	1190	1430	1530	1670	1910	2150	2390	2860	3010	3820	4770
450	637	679	849	1060	1270	1360	1490	1700	1910	2120	2550	2670	3400	4240
500	573	611	764	955	1150	1220	1340	1530	1720	1910	2290	2410	3060	3820
550	521	556	694	868	1040	1110	1220	1390	1560	1740	2080	2190	2780	3470
600	477	509	637	796	955	1020	1110	1270	1430	1590	1910	2010	2550	3180
650	441	470	588	735	881	940	1030	1180	1320	1470	1760	1850	2350	2940
700	409	437	546	682	819	873	955	1090	1230	1360	1640	1720	2180	2730
750	382	407	509	637	764	815	891	1020	1150	1270	1530	1300	2040	2550
800	359	382	477	597	716	764	836	955	1070	1190	1430	1500	1910	2390
900	318	340	424	531	637	679	743	849	955	1060	1270	1340	1700	2120
1060	270	288	360	450	541	577	631	721	811	901	1080	1140	1440	1800
1250	230	245	305	380	458	488	534	610	685	760	915	960	1020	1525

Number of revolutions per minute for various diameters of grinding disks is calculated according to the following formula:

$$n = \frac{60 \cdot v \cdot 1000}{D \cdot \pi}$$

[v = peripheral speed (m/s); D = diameter of grinding disk (mm); π = 3,14; n = number of revolutions per minute (rpm)]

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