

TECHNICAL SOLUTIONS FOR GRINDING

IN THE BEARING MARKET



TECHNICAL GUIDE

NORTON

SAINT-GOBAIN®



BEARINGS

Bearings are mechanical devices used to reduce friction between two components that have a relative movement, most often rotational.

Many shapes, sizes and types of bearings exist including: ball bearings, roller bearings, needle bearings, and tapered roller bearings.

Bearings may be classified according to: the motions they allow, their principle of operation as well as by the direction of the applied load they can handle. Surface quality and tight dimensional accuracy resulting of the grinding and finishing operations, are key to ensure the lifetime of the bearing.

CONTENTS

BEARING MANUFACTURING

5

- 06 Key definitions
- 08 Manufacturing bearing rings
- 10 Manufacturing bearing balls
- 12 Manufacturing rollers
- 14 Product innovation for bearing grinding operations

BONDED ABRASIVES FOR GRINDING ROLLING ELEMENTS

17

- 18 Ball grinding, finishing and lapping
- 22 Diameter grinding of cylindrical and tapered rollers
- 24 Diameter grinding of spherical rollers
- 26 Face grinding of cylindrical and spherical rollers
- 28 Face grinding of taper rollers
- 30 Superfinishing cylindrical and taper rollers
- 32 Superfinishing of spherical rollers

BONDED ABRASIVES AND CBN TOOLS FOR GRINDING BEARING RINGS

35

- 36 Face grinding of inner and outer rings
- 38 Centerless grinding of outer ring
- 42 Shoulder grinding of taper bearing inner rings
- 44 Outside diameter grinding of inner ring raceway
- 46 Inner ring bore grinding
- 49 cBN grinding tools for inner ring bore and outer ring raceway
- 50 Outer ring raceway grinding
- 52 Superfinishing of Inner and outer raceways

COOLANT

57

- 58 Systematic approach to coolant application

SUSTAINABILITY

60

- 60 Our commitments to sustainable development

BEARING MANUFACTURING

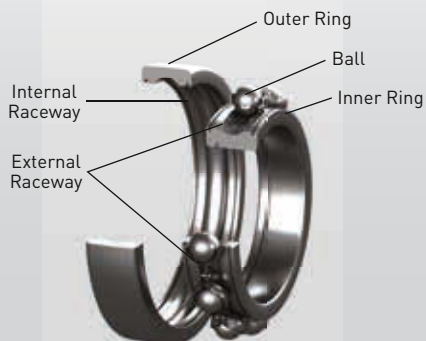


Several steps are involved in the manufacturing of the elements composing the bearing: rings, rolling elements, and cages.

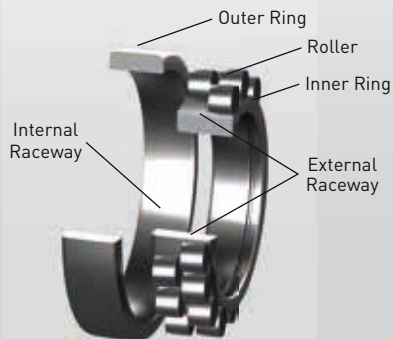
Abrasives play a critical role in the final quality of the bearing and can significantly impact the efficiency of the grinding process.

KEY DEFINITIONS

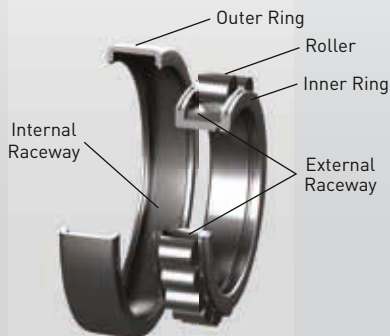
BALL BEARING



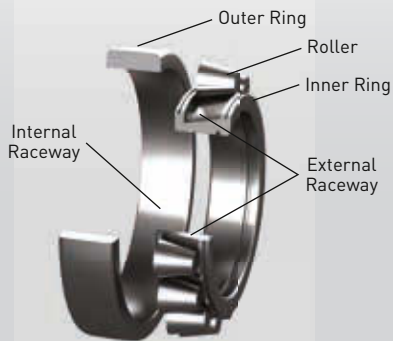
SPHERICAL ROLLER BEARING



CYLINDRICAL ROLLER BEARING



TAPERED ROLLER BEARING



OUTER RING

The outer part of a bearing that fits into the housing and contains the internal raceway for the rolling elements.

INNER RING

The inner part of a bearing that fits on a shaft and contains the external raceway for the rolling elements.

RACEWAY

The ball or roller path, profiled in the inner and outer rings in which the balls or rollers ride. Also called: guide path, race, ball path, roller path.

EXTERNAL RACEWAY

The ball or roller path on an inner ring. Also called: inner race, inner ring race.

INTERNAL RACEWAY

The ball or roller path on the bore of the outer ring. Also called: outer ring race, outer race.

BALL

A spherical rolling element.

ROLLER

Cylindrical or conical rolling element of slightly greater length than diameter.

BALL BEARING - BB

Ball bearings use balls to support the applied load. As there is a point-contact (compared with a line contact for roller bearings) the load carrying capacity is lower than for roller bearings. Ball bearings can support both radial (perpendicular to the shaft) and axial loads (parallel to the shaft).

CYLINDRICAL ROLLER BEARING - CRB

Common roller bearings use cylinders of slightly greater length than diameter.

NEEDLE ROLLER BEARING - NRB

Needle roller bearings use very long and thin cylinders.

TAPERED ROLLER BEARINGS - TRB

Tapered roller bearings use conical rollers that run on conical races.

SPHERICAL ROLLER BEARINGS - SRB

Spherical roller bearings permit angular misalignment, which is possible due to the spherical shape of the internal ring and of the rollers.



BALL BEARING



CYLINDRICAL ROLLER



TAPERED ROLLER



SPHERICAL ROLLER



MANUFACTURING BEARING RINGS

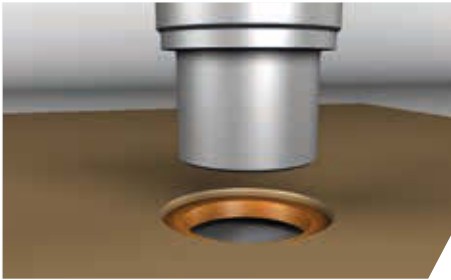
There are five stages involved in manufacturing bearing rings: forming, turning, heat treatment, grinding and assembly.

INITIAL OPERATIONS



RAW MATERIAL

Bars, tubes or sheets of steel (type 100Cr6 and other) are used as the raw material from which bearing rings are manufactured.



PRESSING OR FORGING

Pressing is working the material (steel sheet) and cutting out to make steel rings. Forging is working a slug of previously heated material.



TURNING

Turning describes cold working of the material using a cutting tool on a single spindle turning machine.

HEAT TREATMENT



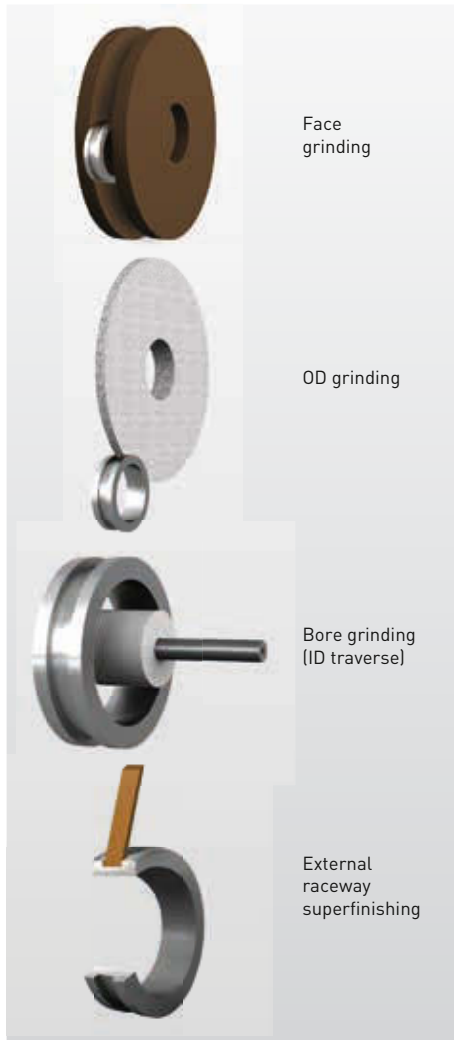
HEAT TREATMENT

Improves material hardness and removes internal stress. Typical operation is performed in three steps: heating to alter material structure, quenching to fix the structure and to improve hardness, and tempering to stabilize the material.

GRINDING OPERATIONS

Typical grinding applications for internal and external rings are face grinding, centerless grinding, outside diameter (OD) and internal diameter (ID) grinding and superfinishing.

INNER RINGS



OUTER RINGS



ASSEMBLY

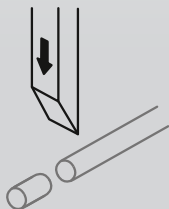
Assembly and final operations, including quality inspections.

MANUFACTURING BEARING BALLS

Steel balls produced for the bearing industry are often made in standard bearing steel 100Cr6 – AISI 52100 (HRC = 60-66) and are produced through a standardized process, of which grinding is a key operation. The diameter of balls range from very small (0.05mm) to large (300 mm), with a majority of 20-30mm.

RAW MATERIAL

Quality steel wires are cut under degassed vacuum to ensure high purity and avoid nonmetallic contaminants.



CUTTING

The steel wire is fed into a machine and cut to the required length.

HEADING

A slug is cold-forge headed into a spherical blank, using formed dies.



PREFORM OR DEFLASHING

The balls are then placed in grooves between two cast iron discs (rill plates). One plate rotates while the other is stationary and the friction removes the flash lines.

HEAT TREATMENT

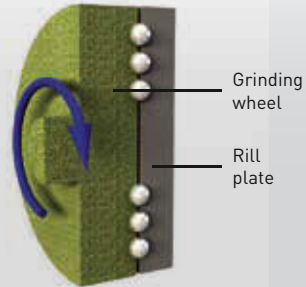
Similarly to rings, the balls are heat treated, quenched and tempered for additional hardness and durability.



GRINDING OPERATIONS

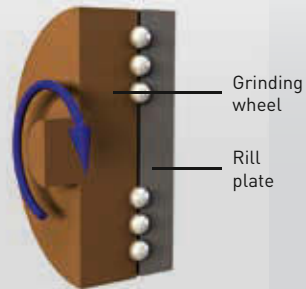
GRINDING

Raw balls are usually ground by rolling under pressure between a cast iron disc (rill plate) and a vitrified grinding wheel. The grit size of the abrasive depends on the dimension of the balls and process requirements. In general, smaller balls require finer grit and harder grade, larger diameter balls require coarser grit and softer grade. Grit size ranges from 120 to 320.



FINISHING

Similar to the grinding process, but with finer grit and an organic bonded wheel. A fine surface finish is achieved during the lapping process with increasingly finer grit sizes ranging from 400 to 2000.



LAPPING

Chemical and mechanical processes give the balls a final micro-smooth finish.



INSPECTION

Every ball is checked and any ball with the slightest defect is removed. This is done either manually or with automated camera detection systems.

MANUFACTURING ROLLERS

Grinding operations significantly differ as a function of roller geometry.

STAMPING

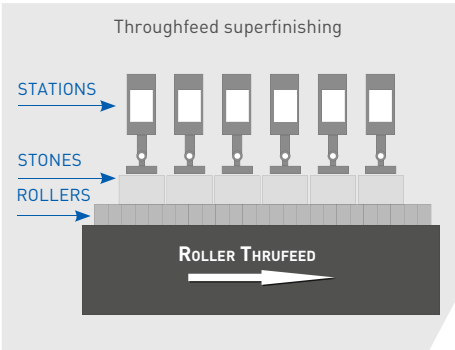
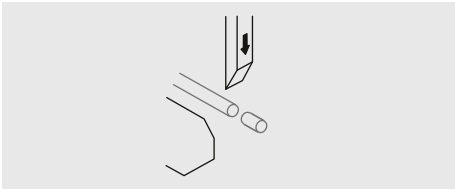
DIAMETER RECTIFICATION

FACE RECTIFICATION

SUPERFINISHING



CYLINDRICAL ROLLER





TAPER ROLLER



SPHERICAL ROLLER



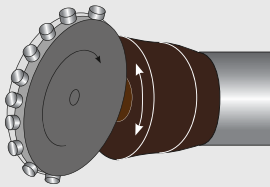
Centerless throughfeed



Outside Diameter grinding plunge



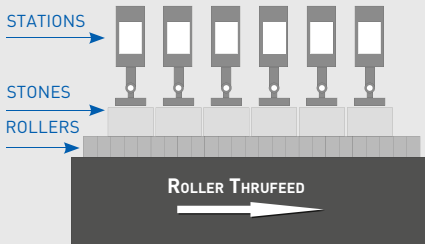
Cup grinding



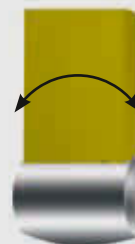
Double disc grinding



Throughfeed superfinishing



Plunge superfinishing



PRODUCT INNOVATIONS FOR BEARING GRINDING OPERATIONS

Norton Vitrium³ bond, Norton Quantum, and Norton Efesis Technology are solutions to increase grinding efficiency and improve part quality.



VITRIUM³

Through Saint-Gobain Abrasives' extensive research and development program in grinding wheel technology, comes Vitrium³ a new generation, patent-pending bond technology.

This revolutionary bond platform features an exclusive chemistry that delivers an entirely new grain adhesion science.

The benefits of Vitrium³ allow cool cutting for increased part quality, profile holding for reduced cost per part, and high speed operations, allowing increased productivity and throughput.



QUANTUM

Norton Quantum is the new generation of ceramic grains designed for maximum performance and cost savings. The new alumina chemistry multiplies the cutting efficiency by controlling the grain breakdown at the micrometric level. This revolutionary ceramic grain is a perfect blend between sharpness (free cutting) and toughness (life). With unrivalled precision, Norton Quantum wheels provide the fastest and finest grinding in the industry.

RESHAPING THE WORLD OF PRECISION GRINDING



VITRIUM³

Exclusive bond chemistry allows higher wheel speed, improved profile holding and reduced work piece burn.



Cutting edge, high performance ceramic grain technology. Multiplies cutting efficiency for maximum performance and unrivalled precision.

WINTER
SAINT-GOBAIN

High precision, high performance diamond dressing tools.

THE
ULTIMATE HIGH
PERFORMANCE
GRINDING
TECHNOLOGY

EFESIS Technology

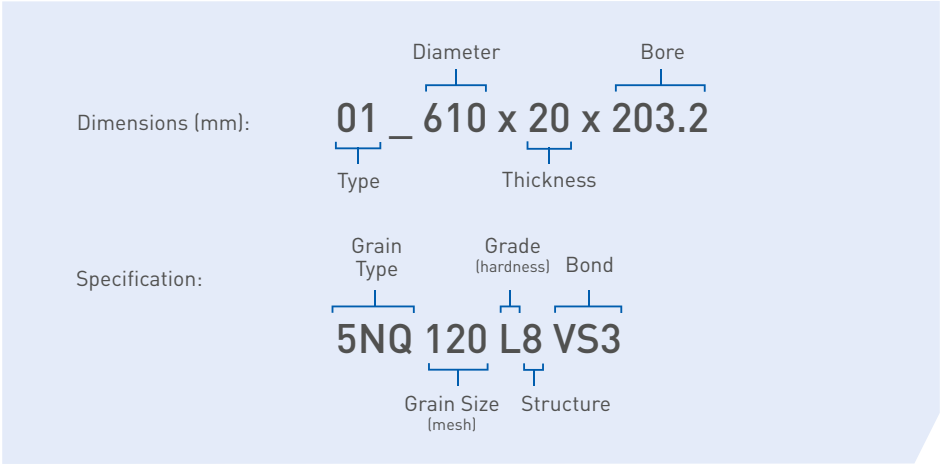
NORTON EFESIS TECHNOLOGY:

Fruit of historical and technical expertise, bond and abrasive grain formulations are optimized to best suit the technical request of grinding operations in the bearing market. Norton Efesis Technology is a complementary range for specialized applications like fine grit ball wheels, cup wheels for tapered bearing, 30AS superfinishing sticks, etc..

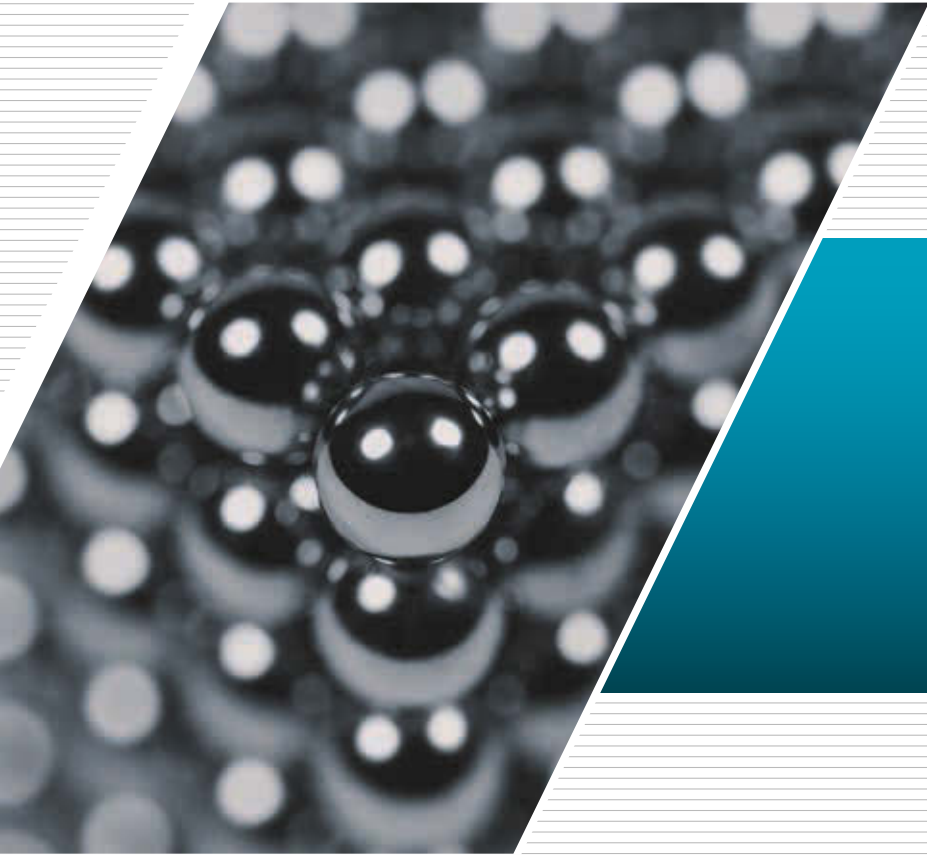
Vitrium³ bond is available under Efesis Technology to improve vitrified product performances in precision grinding applications.

PRODUCT DESCRIPTION

Use the following example as a guide when selecting wheel shape, profile and grit quality.



BONDED ABRASIVES FOR GRINDING ROLLING ELEMENTS



Abrasive wheels and stones for ball & roller grinding, finishing, and lapping.

BALL GRINDING, FINISHING AND LAPPING



Abrasive grinding wheels for ball manufacturing are available in both vitrified and organic bond types, in shapes 35 or 35P (plate mounted). The bonded wheel must be very hard and wear resistant due to the slow turning speed of the machine. The balls are placed on a cast iron plate with grooves allowing them to be ground by the bonded wheel. The grinding process is carried out in several stages that can be grouped into two categories:

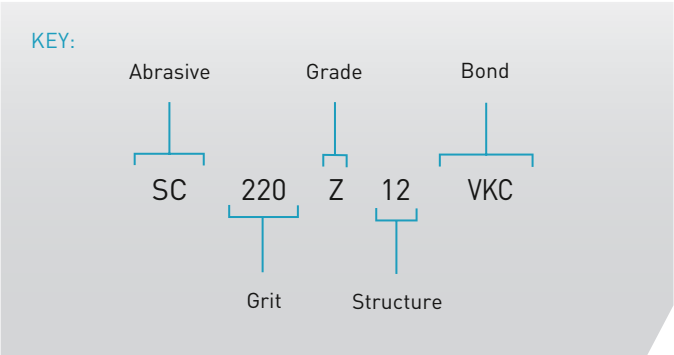
1. Rough grinding operations which are carried out by vitrified wheels to remove large amounts of material.
2. Finishing or lapping operations which are carried out by organic wheels to provide a good surface finish.



ROUGH BALL GRINDING

PRODUCT SELECTION GUIDE

An abrasive and vitrified bond system has been specifically designed for the sub-application:



	GRIT DESCRIPTION	FEATURES	BENEFITS
BEST +++++	SC Silicon Carbide	<ul style="list-style-type: none"> • Excellent cutting power • Sharp and brittle 	<ul style="list-style-type: none"> • Faster metal removal rate • Shorter cycle time • Higher productivity

	BOND DESCRIPTION	FEATURES	BENEFITS
BEST +++++	VKC	<ul style="list-style-type: none"> • High performance bond system • High precision structure control 	<ul style="list-style-type: none"> • Extended wheel life • Higher productivity

WHEEL SELECTION TABLE

Abrasives grit size depends on ball dimension and the process requirements.

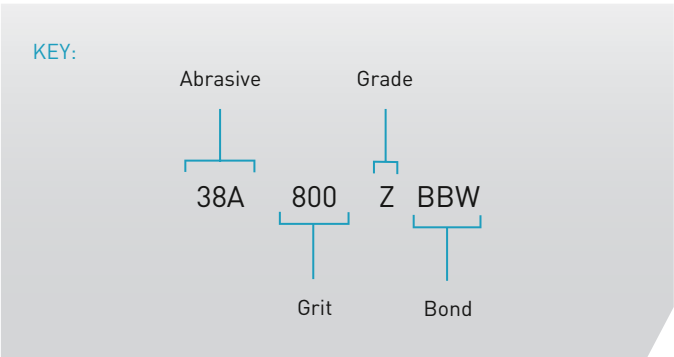
BALL SIZE [mm]	ABRASIVE	GRIT SIZE (FEPA-F)	GRADE	STRUCTURE
4 - 9	SC	220, 280	X, Z	7, 9
9 - 14	SC	220 and 150	X, Z	5, 9
14 - 20	SC	180 and 150	X, Z	5, 9
20 - 60	SC	150 and 120	X, Z	9
60 - 80	SC	150 and 120	T, V, X	9

Other grain combinations are available upon request.

BALL FINISHING

PRODUCT SELECTION GUIDE

An abrasive and organic bond system has been specifically designed for the application:



	GRIT DESCRIPTION	FEATURES	BENEFITS
BEST +++++	38A	<ul style="list-style-type: none">• Conventional fused aluminium oxide• High friability• High purity	<ul style="list-style-type: none">• Highly efficient cutting• Better surface finish

	BOND DESCRIPTION	FEATURES	BENEFITS
BEST +++++	BBW	<ul style="list-style-type: none">• Developed for this application• Excellent quality consistency	<ul style="list-style-type: none">• Excellent technical performance• Extended wheel life

Wheels in grit size 1000 and finer are used to prepare the surface for the final lapping operation in order to reach the required surface quality.

DRESSING BALL WHEELS

Wheels are dressed by diamond blocks to guarantee the constant depth of the grooves.

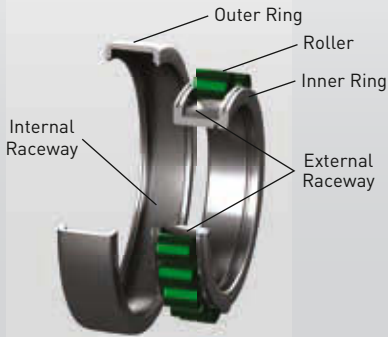
The diamond dressing device is applied across the wheel face while the machine is in operation. The dressing infeed is designed to retain the depth of the grooves formed by the balls themselves, at a value of approximately $\frac{1}{3}$ of the diameter of the ball.

At this value, the balls are $\frac{1}{3}$ inside the wheel, $\frac{1}{3}$ in the rill plate and $\frac{1}{3}$ un-obstructed. This ratio ensures that the ball is ground correctly while running in the grooves at suitable speed.

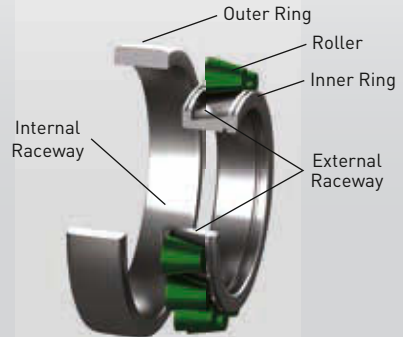


DIAMETER GRINDING OF CYLINDRICAL AND TAPERED ROLLERS

CYLINDRICAL ROLLER BEARING

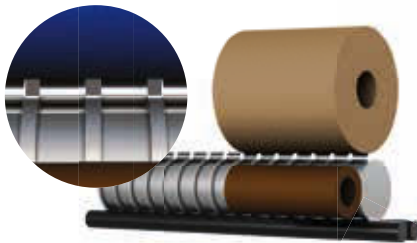


TAPERED ROLLER BEARING

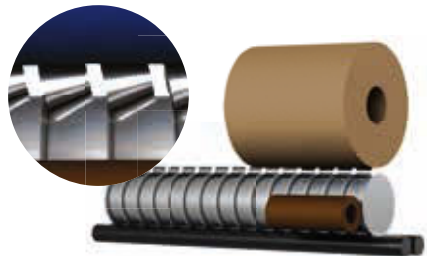


Diameter grinding is carried out after rollers have been heat treated.

Centreless throughfeed grinding is performed on the diameter of cylindrical rollers. For taper rollers a special steel profiled worm wheel is used to carry the rollers. Centreless plunge is used for cylindrical and taper rollers.

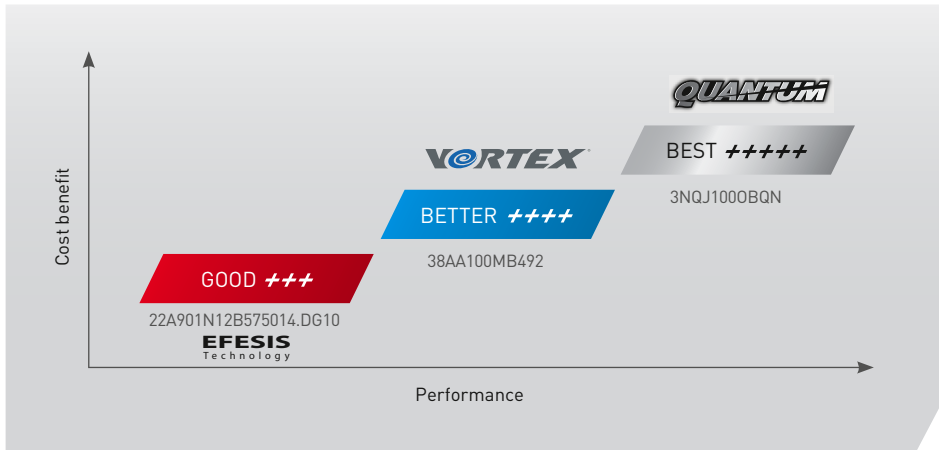


Cylindrical roller






Taper roller








GRIT DESCRIPTION

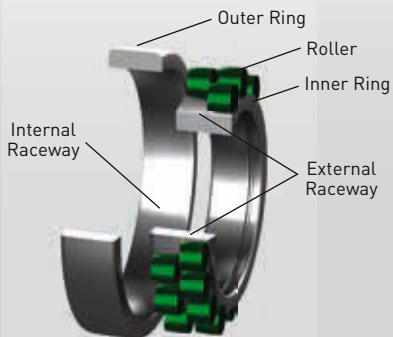
TIER	GRIT TYPE	FEATURES	BENEFITS
BEST +++++	 3NQJ	<ul style="list-style-type: none"> • High performance ceramic • Engineered microstructure ceramic grain • Latest grain technology 	<ul style="list-style-type: none"> • Free cutting action • Long life • For low, medium and high force
BETTER ++++	 38AA	<ul style="list-style-type: none"> • Patented grain technology • Highly porous & permeable for maximizing coolant diffusion in the grinding zone 	<ul style="list-style-type: none"> • High material removal rates • Faster grinding
GOOD +++	 22A	<ul style="list-style-type: none"> • White aluminium oxide 	<ul style="list-style-type: none"> • Good cut rate

BOND DESCRIPTION

TIER	BOND TYPE	FEATURES	BENEFITS
BEST +++++	 BQN	<ul style="list-style-type: none"> • Optimized ceramic bond for new generation ceramic grain Quantum 	<ul style="list-style-type: none"> • Efficient cool cutting
BETTER ++++	 B492	<ul style="list-style-type: none"> • Optimized bond for porous and permeable structures (Vortex) 	<ul style="list-style-type: none"> • Efficient cool cutting
GOOD +++	 B575	<ul style="list-style-type: none"> • Organic bond for conventional grains 	<ul style="list-style-type: none"> • Versatile bond

DIAMETER GRINDING OF SPHERICAL ROLLERS

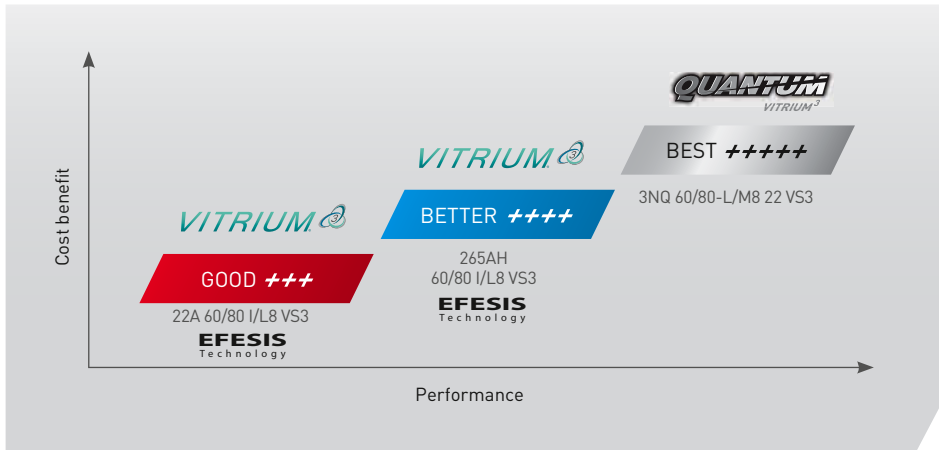
SPHERICAL ROLLER BEARING






The diameter of spherical rollers is rectified after hardening using an Outside Diameter grinding wheel.




Spherical roller



GRIT DESCRIPTION

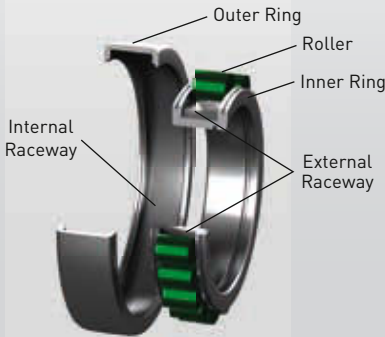
TIER	GRIT TYPE	FEATURES	BENEFITS
BEST +++++	 3NQ	<ul style="list-style-type: none"> • High performance ceramic • Engineered microstructure ceramic grain • Latest grain technology 	<ul style="list-style-type: none"> • Free cutting action • Long life • For low, medium and high force
BETTER ++++	 265AH	<ul style="list-style-type: none"> • High performance pink aluminium oxide 	<ul style="list-style-type: none"> • Fast cut rate
GOOD +++	 22A	<ul style="list-style-type: none"> • White aluminium oxide 	<ul style="list-style-type: none"> • Good cut rate

BOND DESCRIPTION

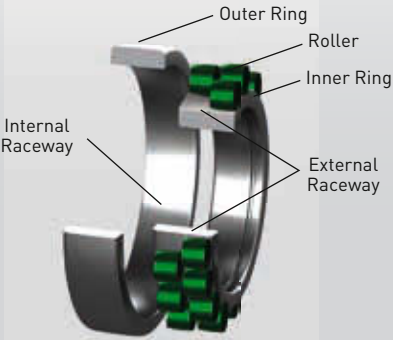
TIER	BOND TYPE	FEATURES	BENEFITS
BEST +++++	 VS3	<ul style="list-style-type: none"> • Latest generation high performance vitrified bond 	<ul style="list-style-type: none"> • High speed operations • Form holding

FACE GRINDING OF CYLINDRICAL AND SPHERICAL ROLLERS

CYLINDRICAL ROLLER BEARING



SPHERICAL ROLLER BEARING



The faces of cylindrical and spherical rollers are rectified after hardening using a double disc grinder. The faces are ground to reach tight parallelism and surface finish quality requirements.



Cylindrical roller

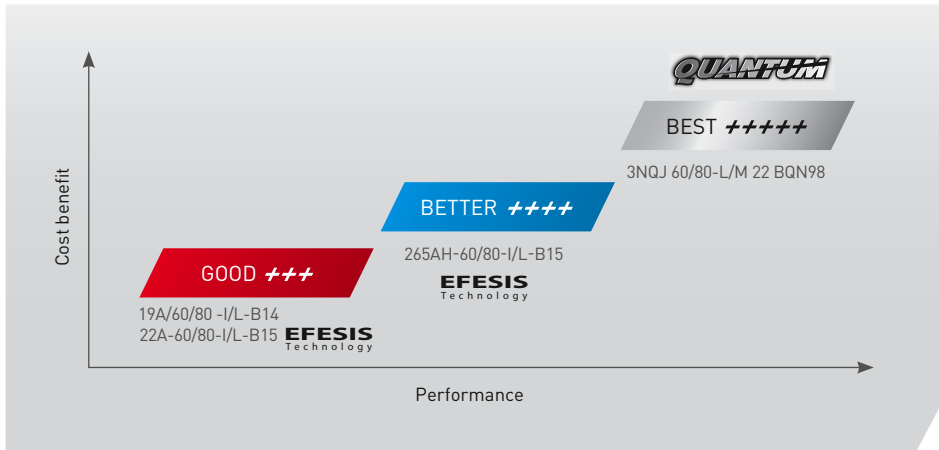


Spherical roller






FACE RECTIFICATION






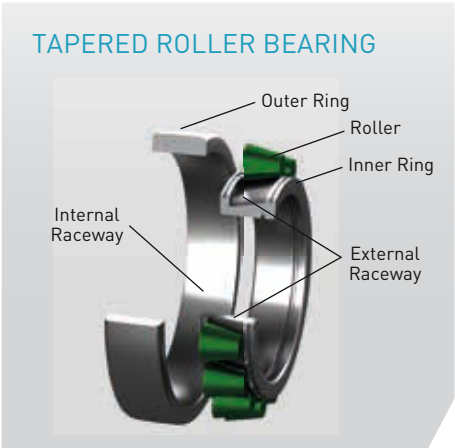
GRIT DESCRIPTION

TIER	GRIT TYPE	FEATURES	BENEFITS
BEST +++++	 3NQJ	<ul style="list-style-type: none"> • High performance ceramic • Engineered microstructure ceramic grain • Latest grain technology 	<ul style="list-style-type: none"> • Free cutting action • Long life • For low, medium and high force
BETTER ++++	 265AH	<ul style="list-style-type: none"> • Pink aluminium oxide 	<ul style="list-style-type: none"> • Fast cut
GOOD +++	19A	<ul style="list-style-type: none"> • Tough conventional aluminium oxide 	<ul style="list-style-type: none"> • Long life
GOOD +++	 22A	<ul style="list-style-type: none"> • White aluminium oxide 	<ul style="list-style-type: none"> • Good cut rate

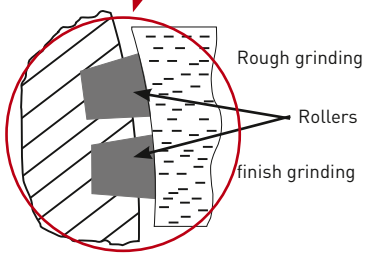
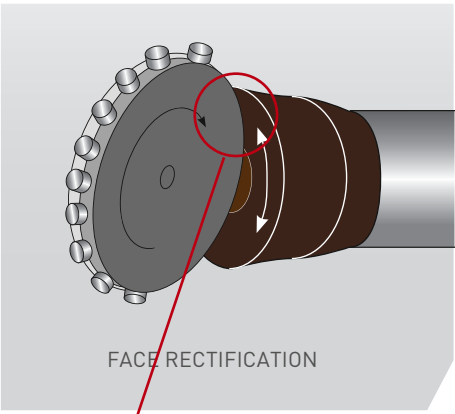
BOND DESCRIPTION

TIER	BOND TYPE	FEATURES	BENEFITS
BEST +++++	BQN98	<ul style="list-style-type: none"> • Optimized organic bond for new generation ceramic grain Quantum 	<ul style="list-style-type: none"> • Higher MRR • Higher G-ratio
GOOD +++	B14	<ul style="list-style-type: none"> • Organic bond for conventional grains 	<ul style="list-style-type: none"> • Versatile bond
GOOD +++	 B15	<ul style="list-style-type: none"> • Organic bond for conventional abrasives 	<ul style="list-style-type: none"> • Good cut rate

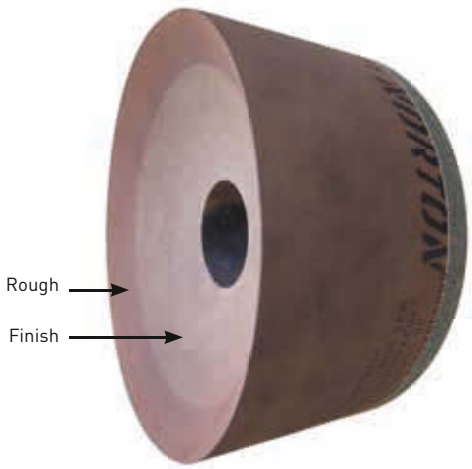
FACE GRINDING OF TAPER ROLLERS

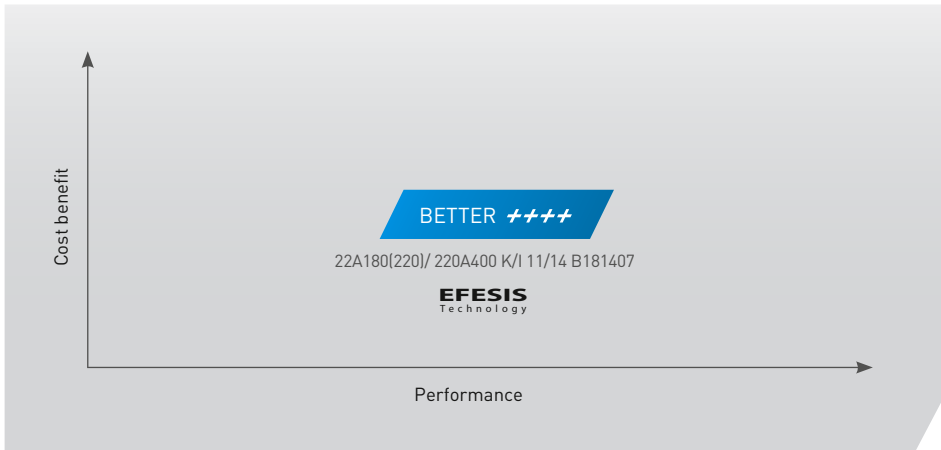


Rectification of the faces of taper rollers is performed using a disc grinder form 35.



Taper roller





GRIT DESCRIPTION

TIER	GRIT TYPE	FEATURES	BENEFITS
BETTER +++++	EFESIS Technology 22A - Coarse 220A - Fine	<ul style="list-style-type: none"> Conventional aluminium oxide abrasive 	<ul style="list-style-type: none"> Good cut rate

BOND DESCRIPTION

TIER	BOND TYPE	FEATURES	BENEFITS
BETTER +++++	B18 EFESIS Technology	<ul style="list-style-type: none"> Organic bond for conventional abrasives 	<ul style="list-style-type: none"> Versatile bond

DRESSER RECOMMENDATIONS:

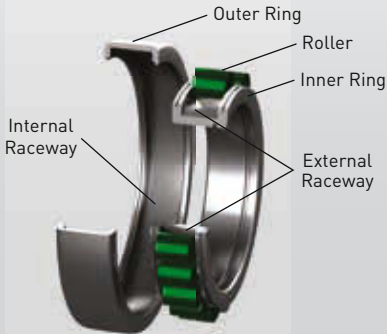
Single point dresser made of synthetic diamond (CVD or MCD) or natural diamond, preferably an octahedron. Diamonds of many different grades and dimensions are available to best suit the application.



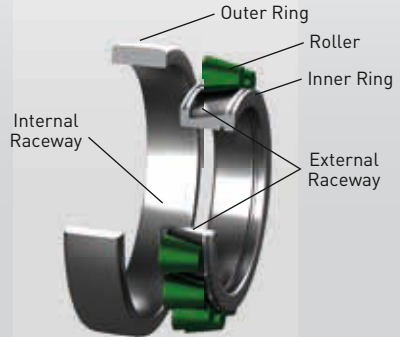
WINTER
SAINT-GOBAIN

SUPERFINISHING CYLINDRICAL AND TAPER ROLLERS

CYLINDRICAL ROLLER BEARING



TAPERED ROLLER BEARING



Superfinishing is the final process that uses abrasive wheels in roller manufacturing. It is a low pressure operation designed to remove the damaged material produced by previous grinding operations and minimize friction when bearings are in use. The rolling surface of rollers are the parts which are superfinished.

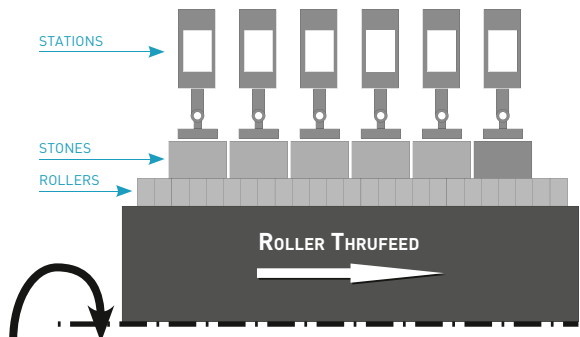
The most common operation in roller superfinishing is centreless thrufeed. The rollers are fed by two cylinders and a number of stones are pushed onto the rollers which flow under them. The stones vibrate to help abrasion and self dressing.

The number of stones (or stations) in a thrufeed machine ranges between 4 and 12, but 6 is most common. (see diagram below)

Stone specifications are selected for stock removal at the first station, and surface finishing at the last station. The first station uses coarse white alumina then finer green silicon carbide on the latter stations. The very last station for polishing uses fine grit organic bonded stones to achieve a polished, high shine result.

TOP TIP

Specifications for roller superfinishing are softer and more open than for races as the contact area is larger and oscillation is replaced by vibration.



PRODUCT SELECTION GUIDE

CYLINDRICAL & TAPERED ROLLERS



	SMALL SIZE DIAMETER 3-10 mm	LARGE SIZE DIAMETER 11-20 mm
ROUGHING	BEST +++++ 30AS 600-500 F8 V6448P15AF11	BEST +++++ 30AS 400 H6 V6448P15AF11
	BETTER ++++ SA 600 -500 F/G V S5 or W	BETTER ++++ SA 320 F/I V S5 or W
SEMI-FINISHING	BEST +++++ 30AS 1000-800 F8 / H6 V6448P15AF11	
	BETTER ++++ MVC 1000-800 H/L VM14 S5 or W	BETTER ++++ SA 600-500 F/G V S5 or W
FINISHING		BEST +++++ 30AS 1000 F8 V6448P15AF11
	BETTER ++++ MVC 1200 H/L S5 or W	BETTER ++++ SA 1000-800 D5 V S5 or W
POLISHING	BEST +++++ 31C500 JB860	

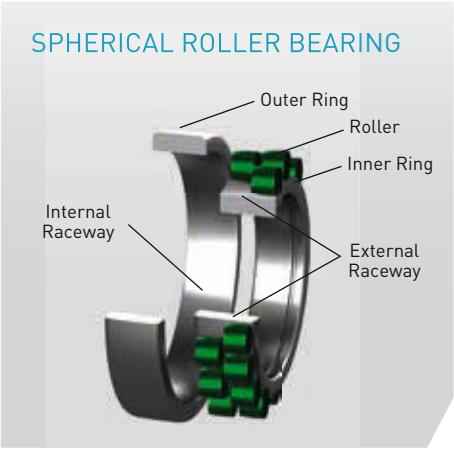
GRIT DESCRIPTION


TIER	GRIT TYPE	FEATURES	BENEFITS
BEST +++++	EFESIS Technology 30AS	• Special combination	• Very good compromise between stock removal and surface finish
BETTER ++++	SA	• White aluminium oxide	• High stock removal
	MVC	• Green silicon carbide	• Very good finish

FINAL TREATMENT (S5 - W - F11)

Sticks and stones can be impregnated with sulfur, wax or paraffin. The sulfur treatment (S5) improves the cutting ability of the abrasive and improves the final surface roughness. Due to health and environment regulations and industry standards, new treatments based on wax and paraffin (W and F11) are now available.

SUPERFINISHING OF SPHERICAL ROLLERS



	SMALL SIZE 20 mm	LARGE SIZE 100 mm
ROUGHING	BETTER ++++ SA800 D0VEA S5	BETTER ++++ CSA 400E5 600F/G VS5
FINISHING	BETTER ++++ SA 1000 E2 VM S5 or SA1000 D5 V S5	

GRIT DESCRIPTION

TIER	GRIT TYPE	FEATURES	BENEFITS
BETTER ++++	CSA	• White aluminium oxide	• High stock removal
	SA	• White aluminium oxide	• Very good finish

TROUBLESHOOTING

TROUBLESHOOTING BY SPECIFICATION ADJUSTMENT

TECHNICAL FAILURE	GRAIN FRIABILITY	GRIT SIZE	HARDNESS	STRUCTURE
Stone glazing	Increase	Coarser	Decrease	More open
Stone loading	No effect	Coarser	Decrease	Less open
Surface finish too rough	No effect	Finer	Increase	Less open
Surface finish too smooth	No effect	Coarser	Decrease	More open
Poor stone life	Decrease	Finer	Increase	Less open
Low stock removal	Increase	Coarser	Decrease	More open

TROUBLESHOOTING BY MACHINE SET-UP

TECHNICAL FAILURE	FEED PRESSURE	STONE OSCILLATION	WORKPIECE ROTATION	COOLANT
Stone glazing	Increase	Increase	Decrease	Clean
Stone loading	Increase	Increase	Decrease	Clean
Surface finish too rough	Decrease	Decrease	Increase	No effect
Surface finish too smooth	Increase	Increase	Decrease	Clean
Poor stone life	Decrease	Decrease	Increase	No effect
Low stock removal	Increase	Increase	Decrease	Clean

NOTES

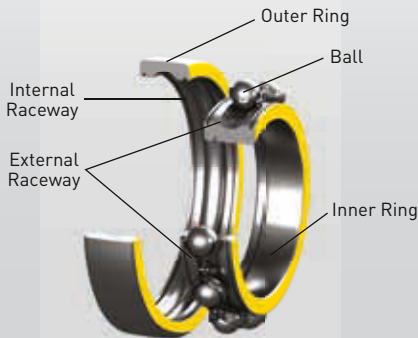
This image shows a blank sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

BONDED ABRASIVES & cBN TOOLS FOR GRINDING BEARING RINGS

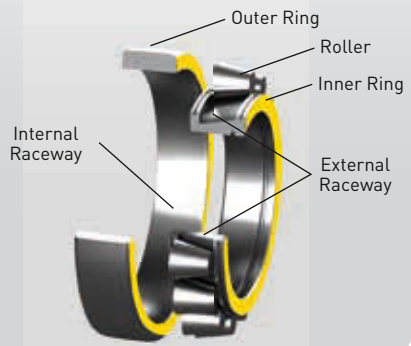


FACE GRINDING OF INNER AND OUTER RINGS

BALL BEARING

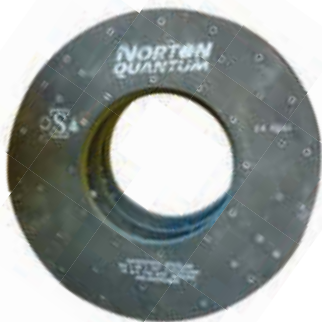
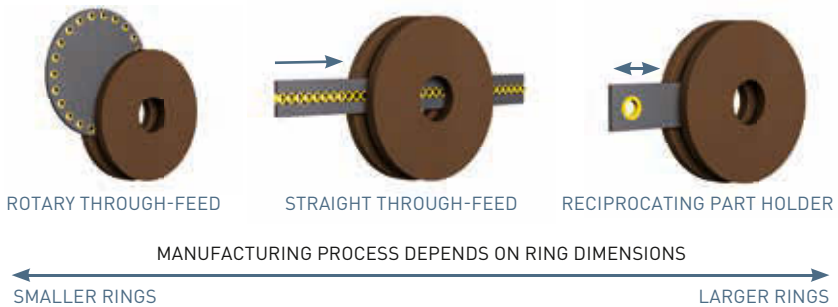


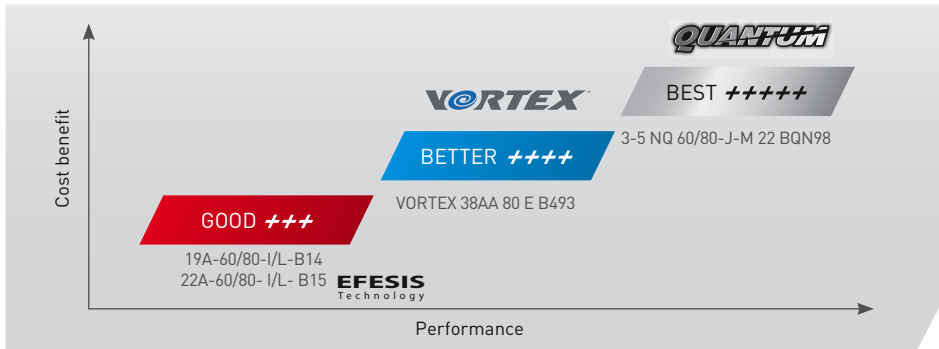
TAPERED ROLLER BEARING



After heat treatment, the ring faces are made flat and parallel. This operation is performed for all types of bearings.

This is done by grinding the sides of the rings on a double disc grinding machine which enables high quality grinding at high production rates.





GRIT DESCRIPTION

TIER	GRIT TYPE	FEATURES	BENEFITS
BEST +++++	 3-5NQ	<ul style="list-style-type: none"> High performance ceramic Engineered microstructure ceramic grain Latest grain technology 	<ul style="list-style-type: none"> Free cutting action Long life For low, medium and high force
BETTER ++++	 38AA	<ul style="list-style-type: none"> Patented grain technology Highly porous & permeable for maximizing coolant diffusion in the grinding zone 	<ul style="list-style-type: none"> High material removal rates Faster grinding
GOOD +++	19A	<ul style="list-style-type: none"> Conventional tough aluminium oxide abrasives 	<ul style="list-style-type: none"> Good cut rate
GOOD +++	 22A	<ul style="list-style-type: none"> Conventional white aluminium oxide 	<ul style="list-style-type: none"> Good free cutting

BOND DESCRIPTION

TIER	BOND TYPE	FEATURES	BENEFITS
BEST +++++	 BQN98	<ul style="list-style-type: none"> Optimized bond for new generation ceramic grain Quantum 	<ul style="list-style-type: none"> Higher MRR Higher G-ratio
BETTER ++++	 B493	<ul style="list-style-type: none"> Optimized bond for porous and permeable structures (Vortex) 	<ul style="list-style-type: none"> Cooler cut
GOOD +++	 B15	<ul style="list-style-type: none"> Good performance bond with conventional grains 	<ul style="list-style-type: none"> Good grain holding
GOOD +++	B14	<ul style="list-style-type: none"> Organic bond for conventional grains 	<ul style="list-style-type: none"> Versatile bond

DRESSER RECOMMENDATIONS:

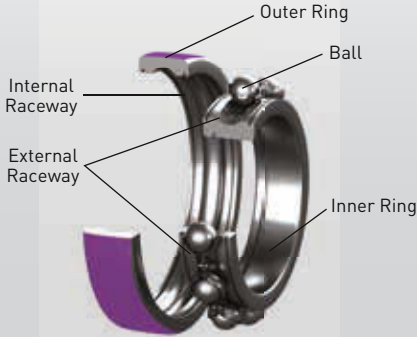
WINTER
SAINT-GOBAIN



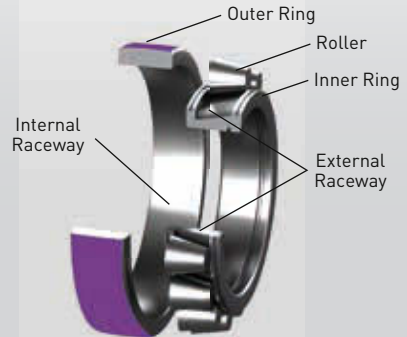
Multi point dressers are recommended for disc grinding wheels

CENTERLESS GRINDING OF OUTER RINGS

BALL BEARING

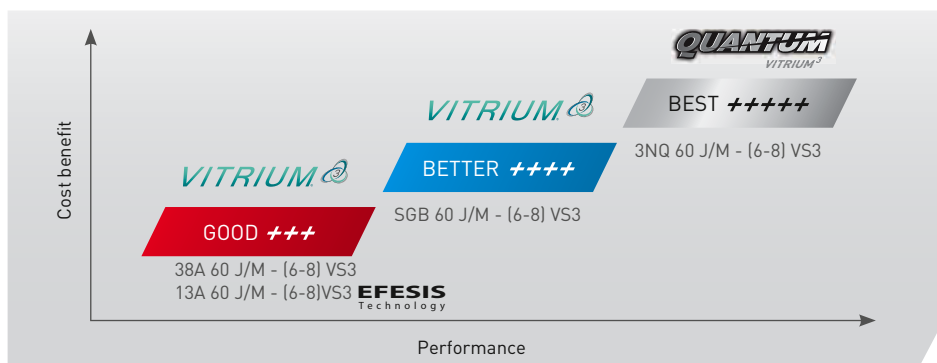


TAPERED ROLLER BEARING



Centerless throughfeed grinding of the outer rings is performed to ensure the right ovality and to remove surface defects from the hardening process





GRIT DESCRIPTION

TIER	GRIT TYPE	FEATURES	BENEFITS
BEST +++++	 3NQ	<ul style="list-style-type: none"> Engineered microstructure ceramic grain Latest grain technology Engineered grain boundaries 	<ul style="list-style-type: none"> Free cutting action Long life For low, medium and high force
BETTER ++++	SGB	<ul style="list-style-type: none"> Medium ceramic content Tougher grain Dilution with strong abrasive 	<ul style="list-style-type: none"> Good cutting effect Longer wheel life
GOOD +++	38A	<ul style="list-style-type: none"> White aluminium oxide grain High friability abrasive 	<ul style="list-style-type: none"> Free cutting
GOOD +++	 13A	<ul style="list-style-type: none"> Conventional brown aluminium oxide 	<ul style="list-style-type: none"> Long life

BOND DESCRIPTION

TIER	BOND TYPE	FEATURES	BENEFITS
BEST +++++	 VS3	<ul style="list-style-type: none"> Latest generation high performance vitrified bond 	<ul style="list-style-type: none"> High speed operations Form holding

New bond Vitrimum³ allows better profile holding, allowing dressing reduction and faster process. **Vitrimum³ bond VS3 replaces traditional VBE bond.**

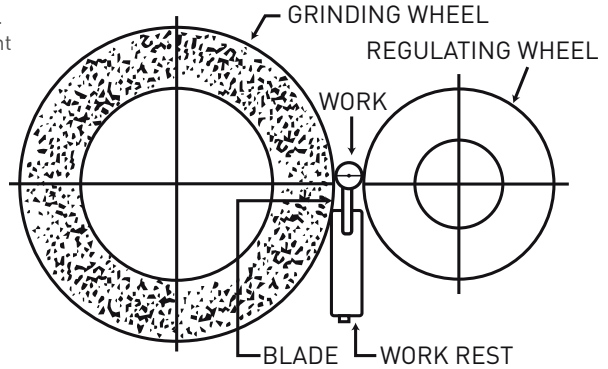
DRESSER RECOMMENDATIONS:

Diamond Fliesen tools are recommended for this application. D30 CVD needle blade is the first choice for dressing the wheels in work.



CENTERLESS FEED (REGULATING) WHEEL

Feed wheel (or regulating wheels) ensure non slippage and correct alignment. They require a long lasting coefficient of friction provided with the high performance rubber R90 bond.



Feed wheels with a high technical specification are essential for centerless grinding. As the throughfeed speed increases it is necessary to use a harder wheel to maintain the correct alignment of the part to the grinding wheel.

GRADE AND STRUCTURE AVAILABILITY:

Grade is a simple progression of hardness scale. R, S, T & U should always be the first choice of hardness. Structure is automatically chosen from the grade.



RECOMMENDED SPECIFICATIONS

Standard operation	A 80 R R90 (equivalent to 13A80R5R907.100 with EFESIS technology)
Improved life or sizing	A 80 S R90 (equivalent to 13A80S3R907.200 with EFESIS technology)
Fast throughfeed rates	A 120 T R90 (equivalent to 13A120T7R907.300 with EFESIS technology)
Irregular shapes	A 120 U R90 (equivalent to 13A120U7R907.400 with EFESIS technology)



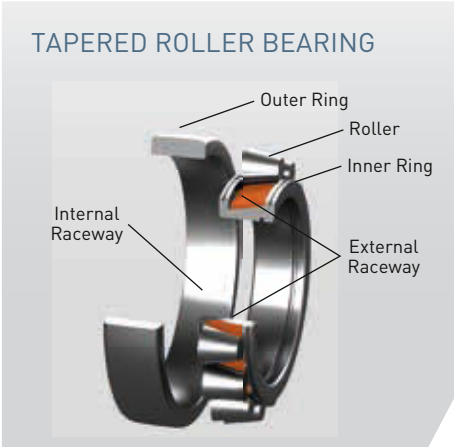
DRESSER RECOMMENDATIONS:

Single point diamond dresser for the rubber feed wheels. D53 single point diamond dressers with PCD plates have been specially designed for conditioning centerless regulating wheels.

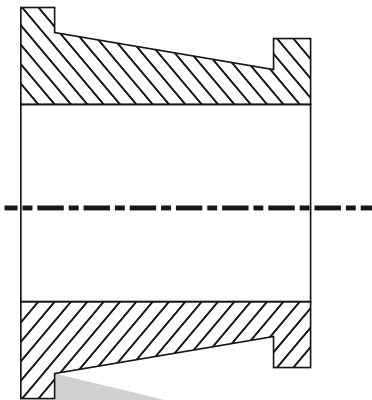
WINTER
SAINT-GOBAIN



SHOULDER GRINDING OF TAPER BEARING INNER RINGS



The raceways are pre-shaped by turning, and the dimensional requirements in terms of roundness and tolerance are obtained by external grinders for the external raceways



Grinding wheel

TOP TIP

Use of VS3 allows softer grades compared to previous generation Norton bond. Softer wheels can be used to prevent burn with higher productivity.

QUANTUM
VITRIUM³
BEST +++++

3NQM 1506 P13 VS3 P15A

VITRIUM
GOOD +++



41A 120 K7 VS3

EFESIS
Technology


Cost benefit

Performance

GRIT DESCRIPTION

TIER	GRIT TYPE	FEATURES	BENEFITS
BEST +++++	 3NQM	<ul style="list-style-type: none"> Engineered microstructure ceramic grain Latest grain technology Engineered grain boundaries 	<ul style="list-style-type: none"> Free cutting action Extremely durable For low, medium and high force
GOOD +++	 41A	<ul style="list-style-type: none"> Conventional aluminium oxide abrasive 	<ul style="list-style-type: none"> Good cutting efficiency

BOND DESCRIPTION

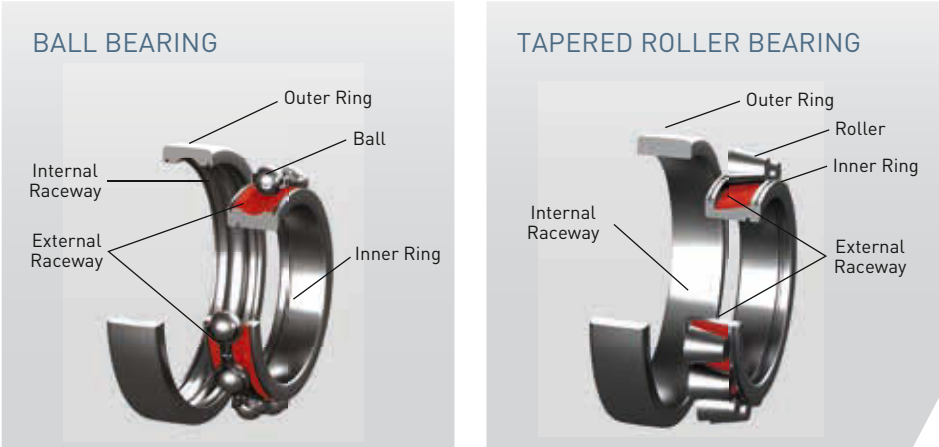
TIER	BOND TYPE	FEATURES	BENEFITS
BEST +++++	 VS3 & VS3.P15A	<ul style="list-style-type: none"> Latest generation high performance vitrified bond Exclusive chemistry that delivers new grain adhesion science Strongest bond, allows more open structures with same strength 	<ul style="list-style-type: none"> Precise profile: reduce cost Cool cutting: improve part quality High speed: increase throughput & productivity

DRESSER RECOMMENDATIONS:

Single point dresser made of synthetic diamond (CVD or MCD) or natural diamond.



OUTSIDE DIAMETER GRINDING OF INNER RING RACEWAY

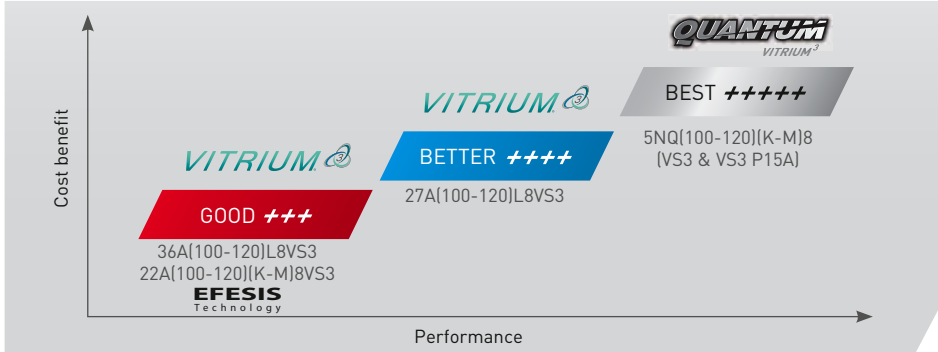


The raceways are pre-shaped by turning, and the dimensional requirements in terms of roundness and tolerance are obtained by external grinders for the external raceways



TOP TIP

Use of VS3 allows softer grades compared to previous generation Norton bond. Softer wheels can be used to prevent burn with higher productivity.



GRIT DESCRIPTION

TIER	GRIT TYPE	FEATURES	BENEFITS
BEST +++++	 5NQ	<ul style="list-style-type: none"> Engineered microstructure ceramic grain Latest grain technology Engineered grain boundaries 	<ul style="list-style-type: none"> Free cutting action Extremely durable For low, medium and high force
BETTER ++++	27A	<ul style="list-style-type: none"> Monocrystalline aluminium oxide Tough grain 	<ul style="list-style-type: none"> Very sharp Durable
GOOD +++	36A	<ul style="list-style-type: none"> Special pink aluminium oxide 	<ul style="list-style-type: none"> Good cutting efficiency
GOOD +++	 22A	<ul style="list-style-type: none"> Conventional white aluminium oxide 	<ul style="list-style-type: none"> Good cut rate

BOND DESCRIPTION

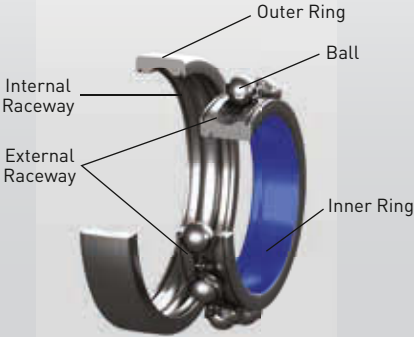
TIER	BOND TYPE	FEATURES	BENEFITS
BEST +++++	 VS3 VS3 P15A	<ul style="list-style-type: none"> Latest generation high performance vitrified bond Exclusive chemistry that delivers new grain adhesion science Strongest bond, allows more open structures with same strength P15A for more porous structures 	<ul style="list-style-type: none"> Precise profile: reduce cost Cool cutting: improve part quality High speed: increase throughput & productivity

DRESSER RECOMMENDATIONS:

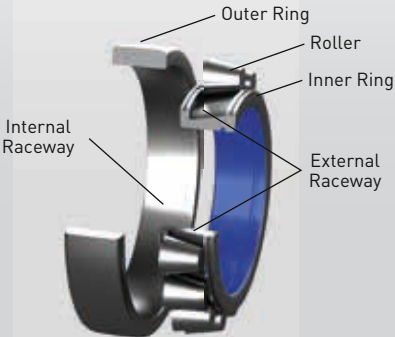
Single point dresser or diamond profile roller dressers which are particularly suitable for complex profiles in mass production.

INNER RING BORE GRINDING

BALL BEARING



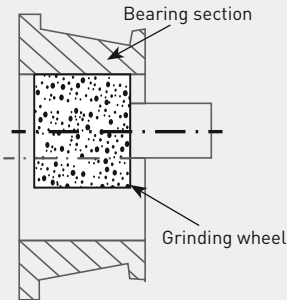
TAPERED ROLLER BEARING



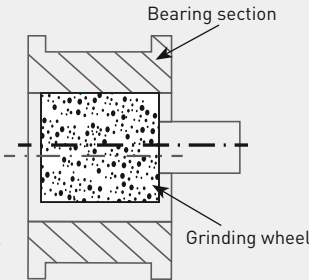
A critical operation in producing bearing rings is Internal Diameter grinding (ID grinding) to make the bore straight and smooth. Perfect macrogeometry (linearity, roundness, conicity) is required to allow the bearing to work without vibration. The finish provided is also critical to minimize friction and allow the final superfinishing operation.

In most cases, grinding is performed in a single operation with only one wheel. Vitrified bonds are most commonly used in these applications.

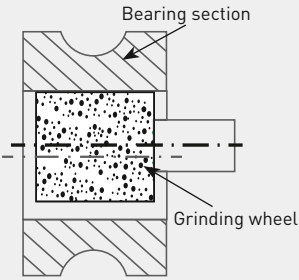
TAPERED BEARING



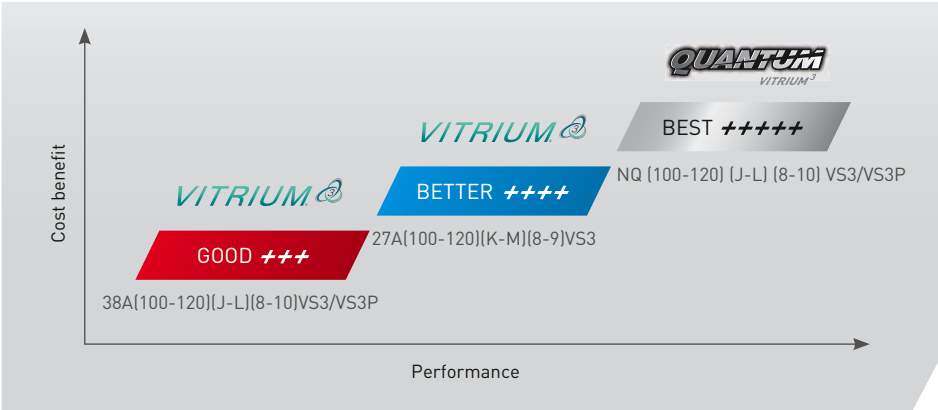
CYLINDRICAL BEARING




BALL BEARING




PRODUCT SELECTION GUIDE FOR MATERIAL 100Cr6



GRIT DESCRIPTION

TIER	GRIT TYPE	FEATURES	BENEFITS
BEST +++++	 NQ	<ul style="list-style-type: none"> Engineered microstructure ceramic grain Latest grain technology Engineered grain boundaries 	<ul style="list-style-type: none"> Optimize cost saving and maximise performance Extremely durable Free cutting action For low, medium and high force
BETTER ++++	27A	<ul style="list-style-type: none"> Microcrystalline aluminium oxide Tough grain 	<ul style="list-style-type: none"> Very sharp Durable
GOOD +++	38A	<ul style="list-style-type: none"> White aluminium oxide Conventional abrasive grain 	<ul style="list-style-type: none"> High cutting power

BOND DESCRIPTION

TIER	BOND TYPE	FEATURES	BENEFITS
BEST +++++	 VS3/VS3P	<ul style="list-style-type: none"> Vitrified durable bond Latest generation bond Features an exclusive grain adhesion science that delivers an entirely new grain adhesion science 	<ul style="list-style-type: none"> Form holding Longer wheel life For low, medium, and high force



Grit size is determined by surface finish requirement:

GRIT SIZE SELECTOR	GRIT SIZE					
Surface finish Ra, microns	46	60	80	100	120	150
0.80						
0.70						
0.50						
0.40						
0.35						
0.25						
0.20						
0.17						

DRESSER RECOMMENDATIONS:

We recommend the use of single point dresser of maximum 0.25 carat or cup dresser.

WINTER
SAINT-GOBAIN



cBN GRINDING TOOLS FOR INNER RING BORE AND OUTER RING RACEWAY

Vitrified cBN tools are characterized by a high wear and temperature resistance. These properties combined with adjustable porosity make this type of tool unique for grinding long chipping materials such as 100Cr6 in a soft or hardened state.

TYPICAL SPECIFICATIONS:

Outstanding grinding results, combined with long lifetime can be obtained with the following specifications:

- B64 VSS 2846 G5AC V360



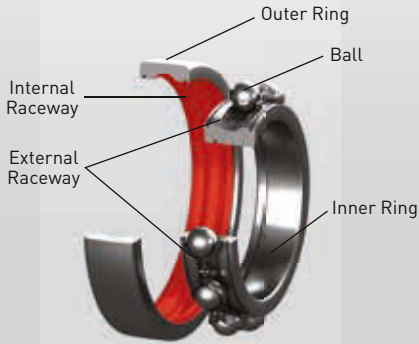
WINTER
SAINT-GOBAIN

B	cBN
64	Grit size
VSS	Bond family vitrified
28	Structure / porosity
46	Type of ceramic bond
G	Grade of hardness
5AC	Manufacturing data
V360	cBN concentration

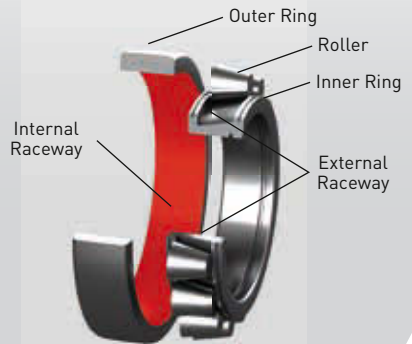


OUTER RING RACEWAY GRINDING

BALL BEARING



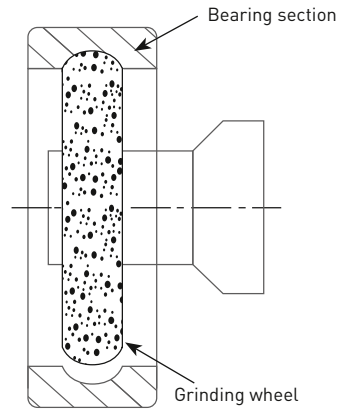
TAPERED ROLLER BEARING



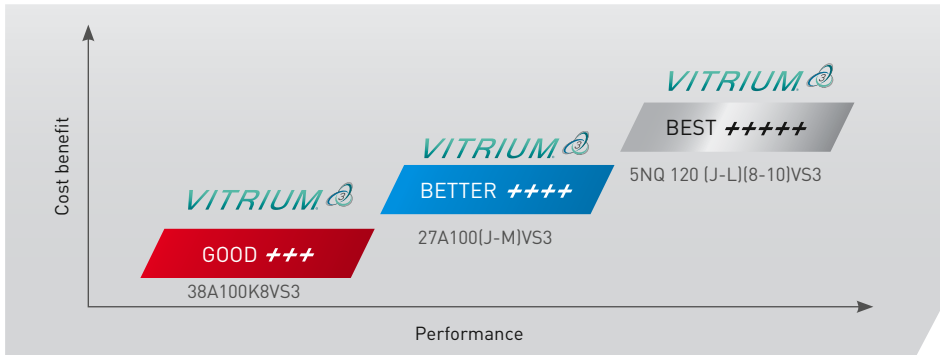
Internal grinding of outer rings is designed to mould the race way to the shape of the rolling elements (balls or rollers).

The technical objectives are:


1. Roughness / surface finish
2. Race width
3. Race deformation
4. Race profile / radius




PRODUCT SELECTION GUIDE FOR MATERIAL 100Cr6



GRIT DESCRIPTION

TIER	GRIT TYPE	FEATURES	BENEFITS
BEST +++++	 5NQ	<ul style="list-style-type: none"> Engineered microstructure ceramic grain Latest grain technology Engineered grain boundaries 	<ul style="list-style-type: none"> Optimize cost saving and maximise performance Extremely durable Free cutting action For low, medium and high force
BETTER ++++	27A	<ul style="list-style-type: none"> Microcrystalline aluminium oxide Tough grain 	<ul style="list-style-type: none"> Very sharp Durable
GOOD +++	38A	<ul style="list-style-type: none"> White aluminium oxide Conventional abrasive grain 	<ul style="list-style-type: none"> High cutting power

BOND DESCRIPTION

TIER	BOND TYPE	FEATURES	BENEFITS
BEST +++++	 VS3	<ul style="list-style-type: none"> Vitrified durable bond Latest generation bond Features exclusive grain adhesion science that delivers an entirely new grain adhesion science 	<ul style="list-style-type: none"> Form holding Longer wheel life For low, medium, and high force

TOP TIP

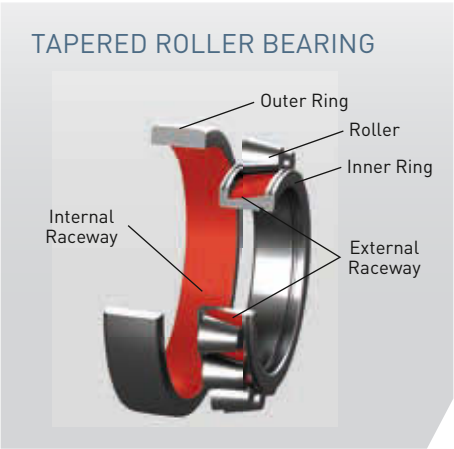
If the dressing operation is made by a diamond roller, select a grinding wheel one grade softer than in the case of a single point diamond dresser.

DRESSER RECOMMENDATIONS:

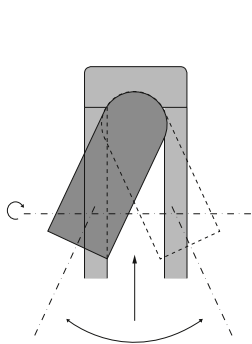
Diamond profile roller dressers, also known as rotary truers, are recommended in plunge for bobine wheels or for special profiles. Single points dressers are recommended for straight wheels.

SUPERFINISHING OF INNER AND OUTER RACEWAYS

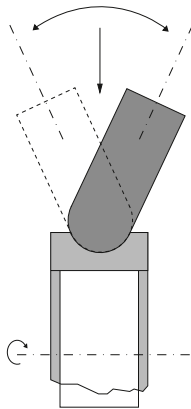
Superfinishing is the final operation performed using abrasives in bearing manufacturing. It is a low temperature and low pressure operation designed to remove the damaged material produced by the grinding operation and minimise friction during usage.



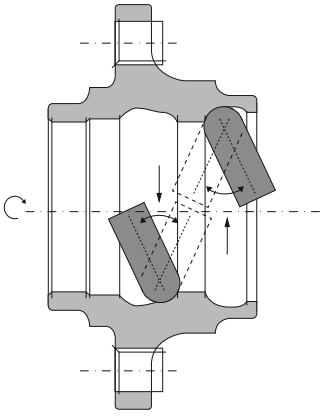
In superfinishing of ball bearing races, the most common configuration is plunge. The ring rotates at high speed while the stones oscillate and are pushed against the race.



Outer ring raceway
superfinishing



Inner ring raceway
superfinishing



Hub bearing raceway
superfinishing

KEY:

■ Abrasive
■ Workpiece

→ ↺ Directional movement of
abrasive and workpiece

For this application, the number of stations is usually one (single operation) or two (roughing + finishing). Two stations usually provide better quality and cycle times, single station reduces abrasive costs.

With a single station process one stone provides both the cutting action and the finish. To achieve the best surface finish the superfinishing cycle is divided into two parts which have different values of ring rotation speed, infeed pressure and stone oscillation.

With a double station process two operations are involved:

1. **ROUGHING:** the first stone provides most stock removal, removing defects left by grinding and delivers an improved surface finish. Select a coarse grit abrasive in white aluminium oxide.
2. **FINISHING:** the second stone removes a smaller amount of material to produce the final desired finish. Select a fine grit silicon carbide abrasive.



BALL BEARING

Stones are self-dressing, retaining their sharpness when working directly on the part.

Parameters measured are:

- Total stock removal
- Surface finish (Ra, Rt and equivalent)
- The level of noise during the process

Coolant used is almost always 100% oil - the presence of water has a negative impact on the surface finish obtained.

The abrasives used are **white aluminium oxide** and **green silicon carbide**.

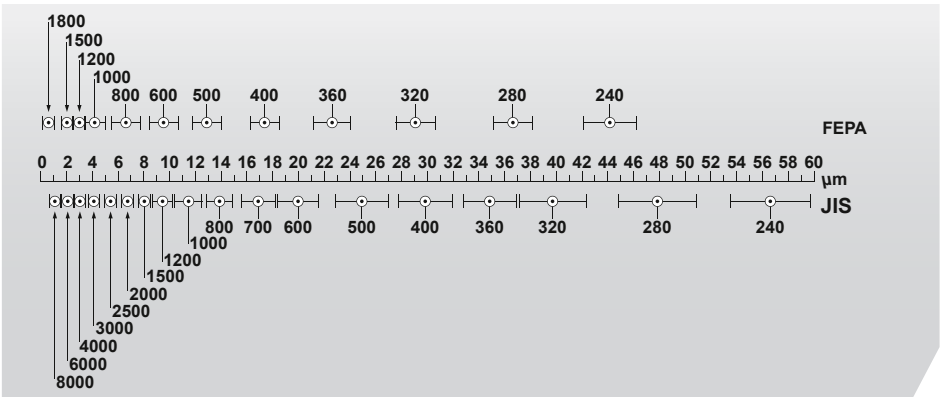
White aluminium oxide provides a better cut, while silicon carbide delivers a better surface finish. The grit size varies according to the surface finish required, which depends on the level of performance of the bearing. Performance is most often connected to the size (diameter) of the bearing. When a very fine finish and excellent shine is required, special polishing abrasive in organic or vitrified bond are used on the final station.

Superfinishing stones are often impregnated with a number of substances including sulfur, wax and paraffin, to increase performance and improve surface finish.

The table below is a guide to help choosing the right grit size for surface finishing and stock removal.

GRIT	RA (MICRONS)	STOCK REMOVAL (MICRONS)
400-500	0.5-0.6	18
500	0.4	16
600	0.2	14
800	0.12	12
1000	0.1	6/8
1200	0.05	4
1500	0.025	2
1800	0.02	

The diagram below shows the correspondence between grit dimensions, FEPA (European) standard and JIS (Japanese) standard:



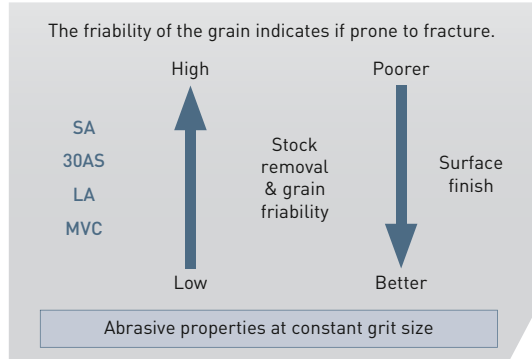
TOP TIP

Norton 30AS stones combine the cutting capabilities of white aluminium oxide and finishing qualities of green silicon carbide.

PRODUCT SELECTION GUIDE

ABRASIVE CHARACTERISTICS

PRODUCT	MARKING	FEATURES
White aluminium oxide	SA	High removal
Norton 30AS	EFESIS Technology 30AS	Good removal, good finish
White aluminium oxide	LA	"softer" than SA, better finish
Green silicon carbide	MVC	Very good finish



DOUBLE OR MULTIPLE STATION

APPLICATION	SMALL SIZE RING DIAMETER 20 mm ----- 50 mm	MEDIUM SIZE RING DIAMETER 50 mm ----- 100 mm
Roughing	SA800 G/J VS5	SA 500/600 D/H V S5
Finishing	MVC15008 H/J VEAMS5	MVC800/ 1200 G/J VEAS5
Polishing	MVC18008 G5VCAM S5/W	

SINGLE STATION

TIER	SMALL SIZE RING DIAMETER 20 mm ----- 50 mm	MEDIUM SIZE RING DIAMETER 50 mm ----- 100 mm
Better	SA1000 D5/K10 V S5	SA 600/800 D/L VS5
Best	30AS800/1000 L3 V6448 F11	30AS800/1000 M3 V6448 F11

FINAL TREATMENT (S5 - W - F11)

Sticks and stones can be impregnated with sulfur, wax or paraffin. The sulfur treatment (S5) improves the cutting ability of the abrasive and improves the final surface roughness. Due to health and environment regulations and industry standards, new treatments based on wax and paraffin (W and F11) are now available.

S5	Sulfur impregnation
W	Wax impregnation
F11	Paraffin impregnation



NOTES

[illegible]

COOLANT

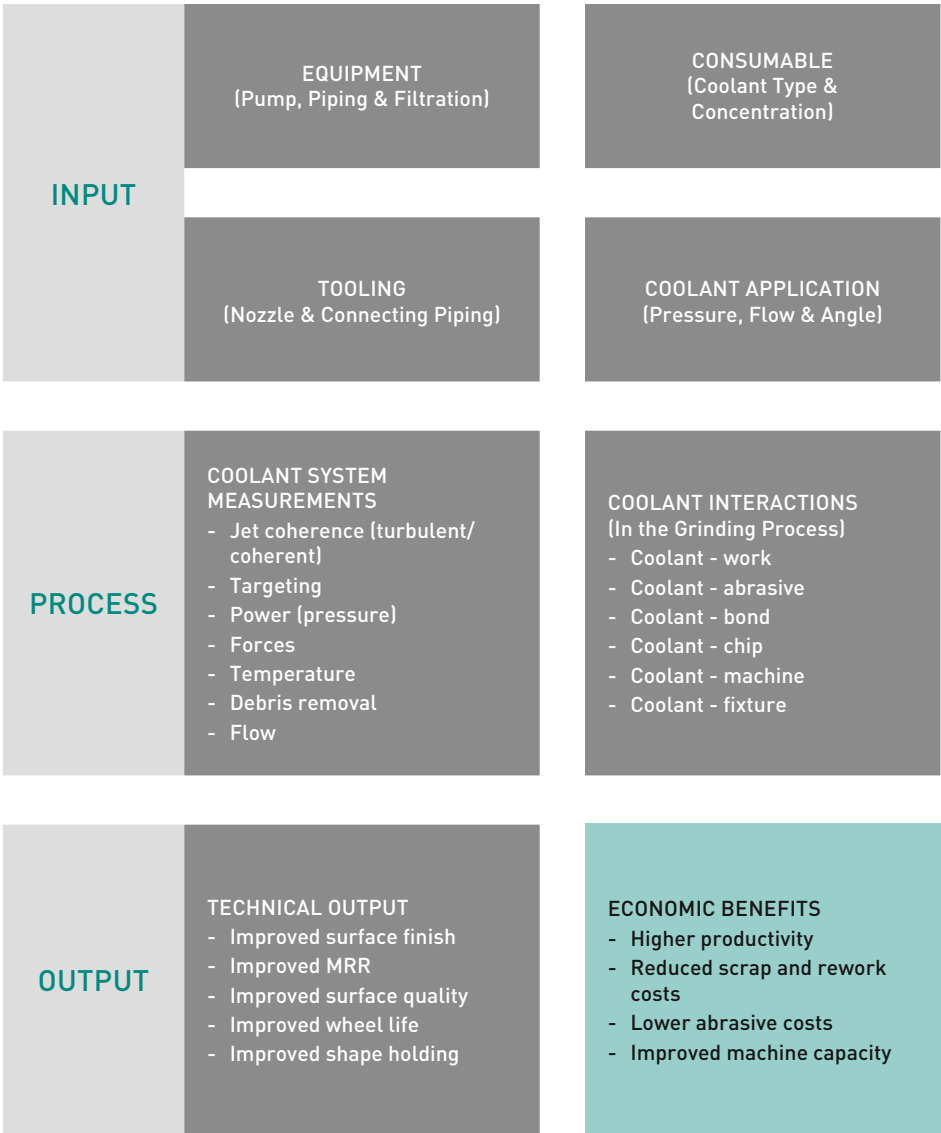


Correct use of grinding fluids is critical in achieving satisfactory results. Quite often, difficult grinding problems can be solved by the optimization of coolant. Grinding fluids serve four important functions:

1. **Lubrication:** reduce grinding forces
2. **Cooling:** remove heat from the grinding zone
3. **Cleaning:** proper coolant application removes chips
4. **Rust prevention:** chemicals used in the coolant help protect ferrous surface from oxydation.

SYSTEMATIC APPROACH TO COOLANT APPLICATION

Coolant optimization can be done within a systematic approach of the grinding process.



COOLANT BEARING OPERATIONS

BEARING PART	PARTICULAR	GRINDING MODE	COOLANT
Ball	Ball grinding	Disc rough grinding	Emulsion or oil
Ball	Ball grinding	Disc finish grinding	Oil or emulsion
Roller	Sides of spherical and tapered rollers	Centerless	Emulsion
Roller	Face of cylindrical and spherical rollers	Double disc grinding	Emulsion
Roller	Sides of spherical rollers	Outside Diameter Grinding	Emulsion
Roller	Sides of tapered rollers	Disc grinding	Emulsion
Rings	Outer ring - Outer surface	Centerless	Emulsion
Rings	Outer ring and inner ring - Sides	Double disc grinding	Emulsion
Rings	Inner ring - Bore	Internal Diameter Grinding - traverse	Emulsion or oil
Rings	Outer ring - Inner raceway	Internal Diameter Grinding - plunge	Emulsion or oil
Rings	Inner ring - Outer raceway	Outside Diameter Grinding	Emulsion or oil
Rings	Raceways	Superfinishing	Oil

GENERAL RULE

Emulsion: better for cooling

Oil: better for surface finish

For material removal prefer emulsion, for finishing prefer oil.

DELIVERING A SUSTAINABLE FUTURE

In 2014 Saint-Gobain Abrasives launched this new sustainability plan aligned with our business values and vision. This 6 point plan of operational policies and practices underpins our commitment to sustainable development as a global leader. We have made significant progress in advancing sustainability with a number of major accomplishments in each area which we have detailed below.

Our commitments to sustainable development

OUR **VISION**

Be the global leader of reference in Abrasives, at the leading edge of innovation and service.

Delivering the most comprehensive Abrasive Solutions to our customers.



OUR **VALUES**

Comprehensively and strictly apply our Saint-Gobain Principles of Conduct & Action.

Conduct

- Professional commitment
- Respect for others
- Integrity
- Loyalty
- Solidarity

Action

- Respect for the law
- Caring for the environment
- Worker health and safety
- Employee rights



Pursue an ambitious policy to constantly **improve workplace health & safety**

Safety is our number one priority:
lost time accidents have reduced
five fold in 10 years

All operators individually assessed at
least 3 times Per annum through the
SMAT program (Senior Management
Audit Tool)
- 9213 individual SMAT's in 2013

21,343 hours of training on Saint-
Gobain Safety Standards

Reduction of workplace hardship:
exposure to noise, repetitive tasks,
safety, ergonomics...

Reduction of exposure
to chemicals

Annual world-wide EHS day

Our commitments
to sustainable development

1.



Continuously encourage the **personal development** of our employees

Saint-Gobain awarded Top Employer
2014 in China, France, and Italy,
plus Top Employer in Europe

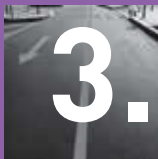
Special focus on diversity, training
and career management

60+ training courses proposed by
Saint-Gobain Abrasives University
and Saint-Gobain Training

Systematic employee satisfaction
surveys

Our commitments
to sustainable development

2.



Be a **responsible & sustainable** player internationally & within our local communities

Founder member of FEPA and oSa, actively promoting the safety of abrasives

Sustainable development policies audited by VERITAS

Sponsors of local communities social through initiatives such as mobility, heating of local schools...

Extensive roll out of international standards ISO 9001, ISO 14001, OHSAS 18001

Internal testing & certification based on the following safety standards:

EN12413: 1999 (Bonded Abrasives)
EN13743: 2002 (Coated Abrasives)
EN13236: 2001 (Super Abrasives)
EN13236: 2001 (Diamond Blades)

Saint-Gobain are endorsers of the Caring for Climate statement and the CEO Water Mandate for Water Resource Protection (as part of the UN's Millennium Development Goals)

Third party supplier charters, timber regulations, CSR evaluations and audits, Adhere process, minerals policy...

Saint-Gobain is a member of the United Nations Global Compact

Our commitments
to sustainable development

3.



Minimize the environmental footprint of our operations with five priorities

Increase the energy efficiency of our production

Increase the use of recycled raw materials in our plants

Reduce CO² emissions

Optimize our water resources

Strict waste segregation policy

Our commitments
to sustainable development

4.



5. Implement **solutions to fossil energy** for our operations

Develop R&D programs notably regarding green electricity, biogas and syngas made from biomass

Our commitments
to sustainable development

5.



6. Continuously **develop eco-valorized products** bringing additional value to our customers

The first abrasives manufacturer to produce FSC® products

Use of natural resins and recycled grains

High performance abrasive products & solutions that help to reduce environmental impact and user exposure:

- low noise
- low vibration
- low dust

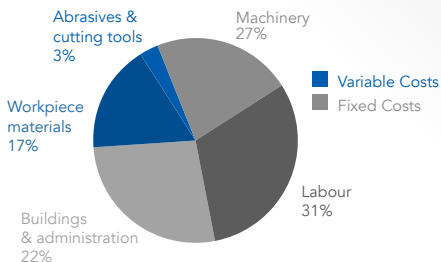
Our commitments
to sustainable development

6.

Typical cost reductions

On average abrasives and cutting tools only account for about 3% of total manufacturing budgets. Norton Bonded products optimised with Norton's proprietary PSP (process solutions program) helps to optimise your total cost and improve your productivity.

For information on how to achieve the greatest overall cost savings, see the example below or go to www.saint-gobain-abrasives.com/psp-eu.aspx.



Decreasing the price of abrasives

A 30% price reduction will only reduce costs per part by 1%.

Increasing the life of abrasives

Even a 50% increase in product life will only reduce costs per part by 1%.

Increase overall productivity through PSP

With a 20% decrease in cycle time per part there will be a reduced total cost per part of more than 15%.

PSP



OUR COMMITMENT: SAFETY, QUALITY AND ENVIRONMENT PRESERVATION

SAFETY

The personal safety of workers using abrasive cutting and grinding wheels is our primary concern. All Norton abrasive wheels are developed, manufactured and safety tested in accordance with the European standard EN12413, safety requirements for bonded abrasive products. In addition, all Norton products meet stringent requirements of the Organization for the Safety of Abrasives (oSa). Saint-Gobain Abrasives is a founding member of the oSa organisation.



QUALITY

Saint-Gobain Abrasives is fully ISO accredited:

- ISO 9001: certifies Quality Management system is in accordance with requirements of quality standards.
- ISO 14001: certifies Environmental Management system is in accordance with requirements of environmental standards.
- OHSAS 18001: health and safety at work certification.

www.norton.eu

Saint-Gobain Abrasifs
European Headquarters
Rue de l'Ambassadeur - B.P.8
78 702 Conflans Cedex
France

Tel: +33 (0)1 34 90 40 00
Fax: +33 (0)1 39 19 89 56

Norton is a registered trademark of Saint-Gobain Abrasives.
Form # 2668

