



# SUNNEN<sup>®</sup> HONING TECHNIQUES

DATA FILE: #105

CHOOSING THE RIGHT STONE

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## CHOICE OF ABRASIVES FOR HONING VARIOUS MATERIALS

### GENERAL

Three types of abrasives are available and in general use for honing: Silicon Carbide, Aluminum Oxide, and Diamond. Each type is bonded into honing sticks called stones, and each has its place in honing; none of the three can be called general purpose for honing all types of materials (*see Figure 1*).

For instance, a honing stone composed of crushed and screened-for-size diamonds bonded together will cut any metal, plastic, or ceramic, but for most materials it would be too expensive - and frequently inefficient - to use. The use of diamond honing stones is reserved for those materials that neither of the other two stone types (Silicon Carbide or Aluminum Oxide) will cut.

In materials where the use of diamond stones is not necessary, either of the other types can be used, but in most cases one will do the job better, faster and more economically than the other. Thus, to get the best results in honing, the most suitable abrasive from among the three types should be used.

### CHARACTER OF WORK MATERIAL (GENERAL TYPES)

TOUGH MATERIALS, both hard and soft, are resistant to shearing and comprise most steels as well as some non-ferrous alloys, and most metals and metal-like materials that have a long chip when drilling or turning. Economical honing of such materials requires an abrasive grain that is more or less shatterproof by the nature of its general shape and crystal structure.

ALUMINUM OXIDE (crushed and screened for size) fits this specification (*see Figures 1 & 2*). It has a chunky shape something like crushed stone, and any point of the grain applied to the work surface

always has a negative rake angle above its cutting point. Ceramic lathe tool bits (throwaway inserts are made of Aluminum Oxide, and these bits are as a rule set with a negative top rake so as to give the cutting edge maximum support (*see Figure 3*).

BRITTLE MATERIALS (either hard or soft) or stringy materials having a low shear resistance cannot be cut as well or as economically with Aluminum Oxide as they can with Silicon Carbide.

Nugget of Aluminum Oxide before crushing shows the chunky shape of grits - a very hard and tough material with colors varying from brown to white.

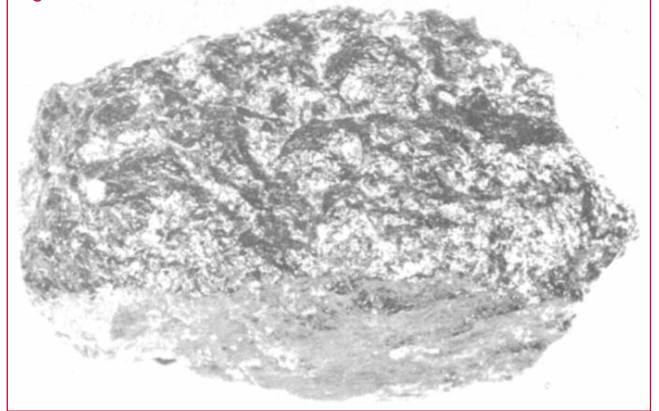


Figure 2, Aluminum Oxide

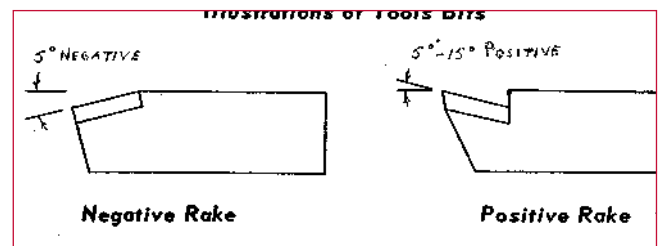
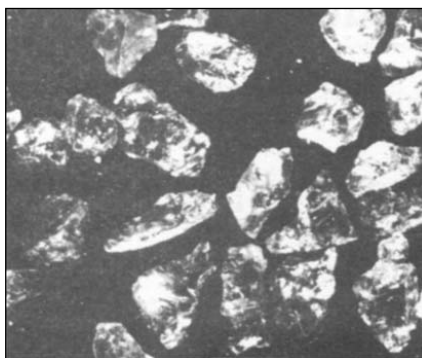
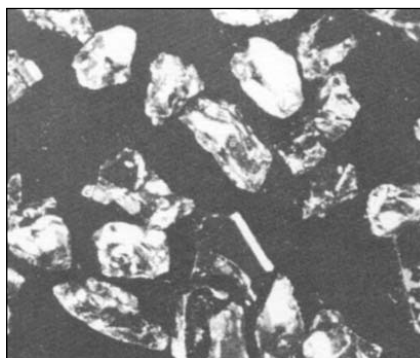


Figure 3, Tool Bits



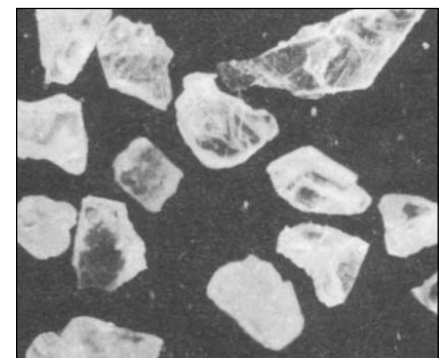
Crushed and screened Aluminum Oxide grit "A" "chunky" and follows no general pattern of cleavage.

Figure 1a, Aluminum Oxide



Crushed and screened Silicon Carbide grit "J" indicates brittleness by its decided cleavage lines and sharp corners.

Figure 1b, Silicon Carbide



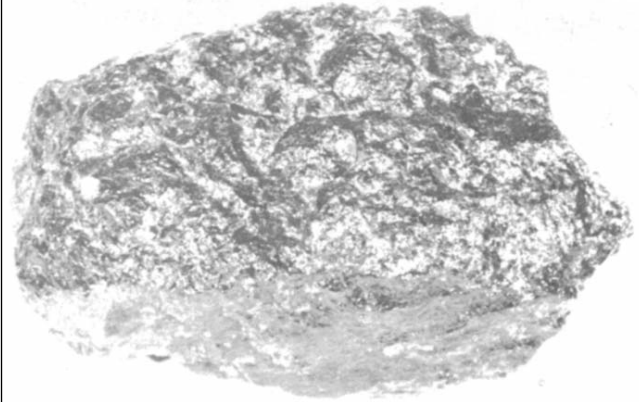
Natural diamond grit "Z", crushed and screened for size. Note the particles all follow the some general cleavage lines.

Figure 1c, Diamond

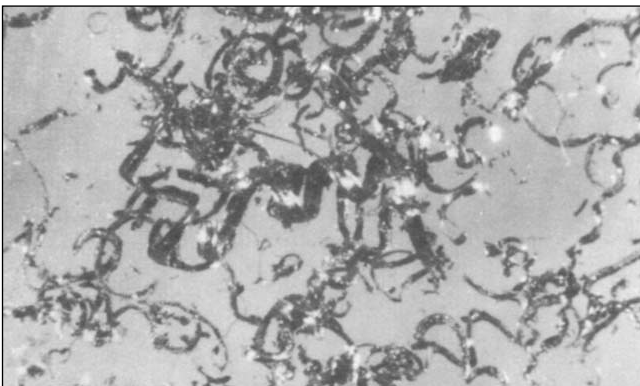
## SUNNEN HONING TECHNIQUES

**SILICON CARBIDE** crushes into splinters of jagged, glasslike grains (*see Figure 4*). A good percentage of these very sharp, splinters like points, when pushed into the work surface will have a decidedly positive rake angle. For honing a material that does not offer too much resistance to shear (so as not to snap off these sharp points) Silicon Carbide has been found to be most effective, cutting such materials with less applied force both as to penetration and shearing.

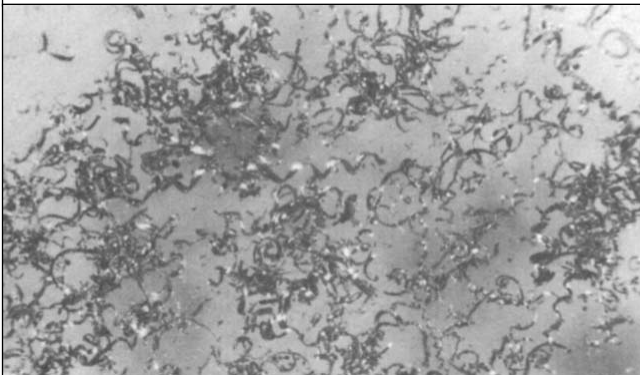
Nugget of Silicon Carbide before crushing indicates its definite splintery, crystalline structure - a very hard and brittle material with glistening blue to black colors.



**Figure 4, Silicon Carbide**



SIZE OF GRITS DETERMINES SIZE OF CHIPS - These honing chips, greatly magnified, (both groups from the same work material but generated by different grit size honing stone) were made by generating a one directional spiral. Crosshatching cuts chips into microscopic lengths. These chips were honed from a tough 'stringy' metal - chips from cast iron or other brittle metals will not 'curt' but will break into short grain-like chips.



**Figure 5, Chips**

These points will stand up while plowing furrows in brittle materials such as cast iron and in low-shear materials like aluminum, plastics, and bearing bronze. It has also been found that in a comparison of Aluminum Oxide and Silicon Carbide of the same grain size, the latter produces a somewhat better and more uniform surface finish. For this reason Silicon Carbide (in the fine grit sizes) is generally used in most materials when very fine finishes are desired.

Note the general shape of the three types of abrasive grains in the magnified photographs on opposite page. Silicon Carbide has sharper flake-like grain points, while Aluminum Oxide has rather solid, blunt, chunky grains.

Aluminum Oxide grains stand up better against high shearing stress and are used in honing tough materials. There is not too much difference in the actual "scratch hardness" of the two grain types, although Silicon Carbide is somewhat harder. The chief difference is in shape and shear strength and the ability of Aluminum Oxide to point-penetrate, under pressure, various types of very hard materials (such as the abrasive-resistant tool steels after hardening).

For a specific material, one type of grain may be recommended for stock removal and another for fine finishing (*see Figure 5*). For example, heavy stock removal in steel calls for Aluminum Oxide ("A"); while fine finishing calls for Silicon Carbide ("J"). The reason is that Aluminum Oxide by virtue of its grain shape and crystal structure will stand the pressure and stress of plowing up heavy chips with a coarse grain. By contrast, in a very fine grain size where penetration is shallow and chips microscopic, no great shearing strength is required and Silicon Carbide will give a quicker, finer and more uniform finish. As a rule, it is used (in 400 or 500 grit sizes), when seeking finishes of 10 microinches or better in almost all metals after they have been roughed and semi-finished with larger grit sizes in Aluminum Oxide or Silicon Carbide.

A typical sequence of operations in steel would be: first, burr and rough-hone with 150 Aluminum Oxide grit to near size, leaving a 55 microinch finish; next, semi-finish to within "tenths" with 280 Aluminum Oxide grit, leaving a surface finish of 25 microinches; and finally, finish with 400 Silicon Carbide grit to obtain final size and a finish of, say, 8 microinches. (If the specifications had called for 25 microinch, the work would have been finished with the 280 grit Aluminum Oxide stone).

**DIAMOND:** Diamond stones should not be used except on materials where the other two abrasive grains are not hard enough to penetrate, such as tungsten carbide, ceramics, glass, and some very dense and hard abrasive-resistant tool steel alloys containing iron-chromium carbides or vanadium carbides.

BORAZON CBN: Some alloys containing cobalt and Boron, even though not so very hard on the Rockwell scale, are also highly resistant to stock removal with ordinary abrasives. Wear-resistant alloys are generally also abrasive resistant, and in most of these cases it often pays to resort to Borazon CBN stones.

There are more than 1,100 producers of metal alloys in the U.S., England and West Germany - each firm producing a number of brand name alloys to a grand total of some 19,000 of such alloys. Therefore, any classification of materials for which the three types of available abrasives are best suited must be general, since not only metals but also many non-metallic parts are honed.

The recommendations given in the table should also be modified by the size and shape of the work, roughness (burrs) in the bore left from previous operations, amount of material to be removed and finish desired, as well as type of material and degree of hardness.

Sometimes our advice may seem inconsistent - for example, deburring with Aluminum Oxide grit stones in car-bides and then removing stock and finishing with diamond grit stones. However, deburring is often a stone-punish-ing job and generally can be accomplished with an inex-pensive stone. Once the burrs are "knocked off," a dia-mond stone will complete the job efficiently and economically.

# SUNNEN HONING TECHNIQUES

## STONE, SELECTION GUIDE' FOR HONING A VARIETY OF MATERIALS (For Internal Diameter Honing Only)

### EXPLANATION OF SUNNEN STONE GUIDE

- The letter at the beginning of the Stone Code designates type of abrasive:  
 A - Aluminum Oxide      J - Silicon Carbide      Z - Diamond      B - Borazon CBN
- The first numeral denotes grit size (the lower the number, the larger the grit size):  
 1 - 70 grit      5 - 220 grit      8 - 400 grit  
 2 - 80 grit      6- 280 grit      9 - 500 grit  
 4 - 150 grit      7 - 320 grit      0 - 600 grit
- The next numeral indicates bond hardness (the lower the number, the softer the bond):  
 1 very soft      7 -  
 3      8-      (Hardness number does not apply to Borazon stones)  
 5      9- extra hard  
 6      13 - extremely hard, for deburring only.

Material	Burr & Rough Hone	Stock Rem. in Base Material	Fine Finish	Material	Buff & Rough Hone	Stock Rem. in Base Material	Fine Finish
Agate	A413	A413	J95	Nitralloy			
Alnico	A413	A57*	J95	Before Nitriding	A413	A57	J95
Aluminum	A413	J57	J95	After Nitriding	A413	B5AA	J93
Aluminum, hard coat	A413	J55	Z07	Porcelain	A413	Z47	Z07
Boron Carbide	A413	Z47	J83	**Rexalloy and similar cemented and cast cutting tool materials	A413	Z47	Z07
Brass (yellow)	A413	J63	J83	Rubber - Hard	A413	J65	J85
Bronze (soft)	A413	J63	J93	Silver	A413	J63	J93
Carbon	A413	J631	J95	Steel Hard	A413	A55*	J93
Cast Iron	A413	J57	Z07	Steel Soft	A413	A57	J95
Cemented Carbides	A413	Z57	Z07	Steel Hi-speed Alloys	A413	A63	J93
Ceramics	A413	Z47	J93			J63	
Chilled Iron	A413	J63	J83			B5AA	
Hard Chromium Plate	A413	A43		Steel - Stainless Soft	A413	A57	J95
Porous Chromium Plate	A413		A43	Hard (over 60 Re)	A413	135AA	J93
Chrome Carbide	A413	Z47	Z07	Stellite	A413	J63*	J93
Colmonoy	A413	Z47	Z07	Titanium	A413	A57	J95
Columbium (see Niobium)				Tantalum Carbide	A413	Z47	Z07
Copper	A413	J63	J93	Titanium Carbide	A413	Z47	Z07
Glass	A413	Z57	Z07	Tungsten Carbide	A413	Z47	Z07
Gold	A413	J63	J83	Tungsten pure	A413	A59	J97
Inconel	A413	B5AA	J95	Vanadium Chrome Steel Alloys	A413	J83	
Lucite	A413	J63	J95	Wrought Iron	A413	A57	J95
Magnesium	A413	J55	J95				
Malleable Iron	A413	J57	J95				
Molybdenum	A413	A413	J99				
Monel Metal	A413	A57	J95				
Niobium	A413	A59	J97				

\* Borazon CBN is recommended for production honing these materials. For more information on your specific application, consult your local Field Service Engineer or call Sunnen Technical Services.

STONE CODE NUMBERS shown in the table control only the abrasive content of the stone (abrasive type, grit size, and bond hardness). To select a stone for a particular size and type of honing tool, the correct STONE SERIES NUMBER must precede the stone code number. This series number controls the dimensional size of the Stone Series Number to match honing tool: P28.

Code Number from table: Z47.

Complete Sunnen Stone Number: P28-Z47.

See the stone selection chart and the supply catalog, available from your Sunnen Field Service Engineer or mailed free on request.

# NOTES

## data files

- 101 - Honing Bores With Keyways And Splines
- 102 - Honing Short Bores
- 103 - Honing Blind Holes
- 104 - Obtaining Specified Finishes By Honing
- 105 - Choosing the Right Stone
- 106 - Honing Tandem Holes
- 107 - Making Manual Honing Easier With Workholders
- 108 - Fixturing Parts For Power Stroking
- 109 - Vertical Hone Fixture
- 110 - Honing Small Bores
- 111 -
- 112 - External Honing
- 113 - Fixturing Design Considerations For Automatic Krossgrinding® Machines

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The fully equipped Automotive and Industrial Technical Service Centers in St. Louis is available to help with any honing problem at any time without cost or obligation. Sunnen factory-trained Field Service Engineers cover the entire country and are always at your service - again, no cost or obligation. Call us whenever you have a bore-sizing problem.

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DF-105 9/09 - POD