Toolholders

The main qualities of an edge-clamping system as part of a toolholder should be to provide satisfactory stability for the insert during machining, facilitate smooth chip flow, tool accessibility, operational versatility, good tool-life and simple maintenance.

Modern toolholders have been designed to provide optimum machining performance in different applications and usually over a broad area. The type of operation and, to some extent, the size of workpiece and cuts determine the selection of edge clamping system. A heavy duty roughing operation on large workpieces makes considerably different demands to those of finishing operations in small part machining.

As a basis the selection of edge clamping system can be taken from the toolholder choice table. The recommended and alternative choices are indicated for each system.

An over-riding recommendation is to use the modern rigid clamping system RC for negative inserts as far as possible to achieve machining security and the means for high cutting data when it comes to external machining.

Light external machining of smaller components is accomodated by the CoroTurn 107 positive insert system.

For internal machining, the hole depth and diameter ratio often determines the choice, with CoroTurn RC and T-MAX P for large and/or shallow holes. CoroTurn 111, with extra positive geometry and extra clearance minimizing boring bar deflection, is especially suitable for deeper holes to produce high surface finish, profiling and when tuned bars are required.

The selection of the actual toolholder style is connected to the insert selection and influenced by feed directions, size of cuts, workpiece and toolholding in machines as well as accessibility required. The shape of the workpiece is influential if contour turning is involved.

Composite operations should be divided into basic cuts for assessment of which toolholder type is most suitable: longitudinal turning, facing, profiling, in-copying, out-copying and out-facing. The listed types are then considered as to combination possibilities or alternatives in order to keep the number of tool types to a minimum, while still providing the best possible performance.

Toolholder types are defined by the entering angle, the shape and size of the insert used. For stability during machining, the largest possible toolholder size should be chosen to suit the application. This provides the most advantageous tool-overhang ratio and the most rigid base for the insert.

Secure insert and toolholder clamping is an essential factor in turning for stability.

CoroTurn RC rigid clamping systems

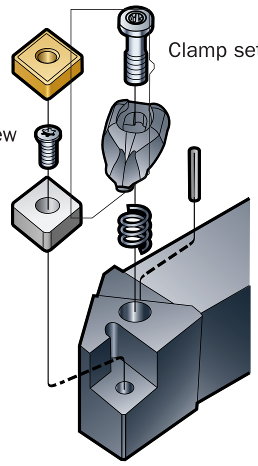
Top and hole clamping

The CoroTurn RC clamping systems use negative, single or double sided inserts.

Stability and security are the key words in turning and sufficient clamping of the insert has a great impact on the quality of the component. As the CoroTurn RC clamping system combines the downward forces from the clamp with the tip seat positioning, it not only presents rigid clamping of the insert but also excellent repeatability when indexing the insert.

CoroTurn RC is the first choice for external turning with negative inserts.

Rigid clamp design (RC)



Available tools:
- Shank holders
- External Coromant Capto cutting units
- Bars
- Cartridges
- SL

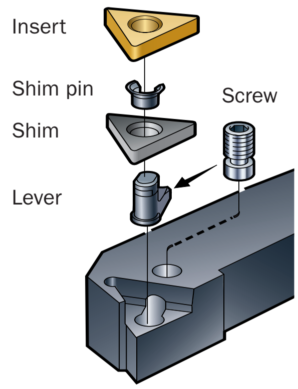
A
B
C
D
E
F
G
H

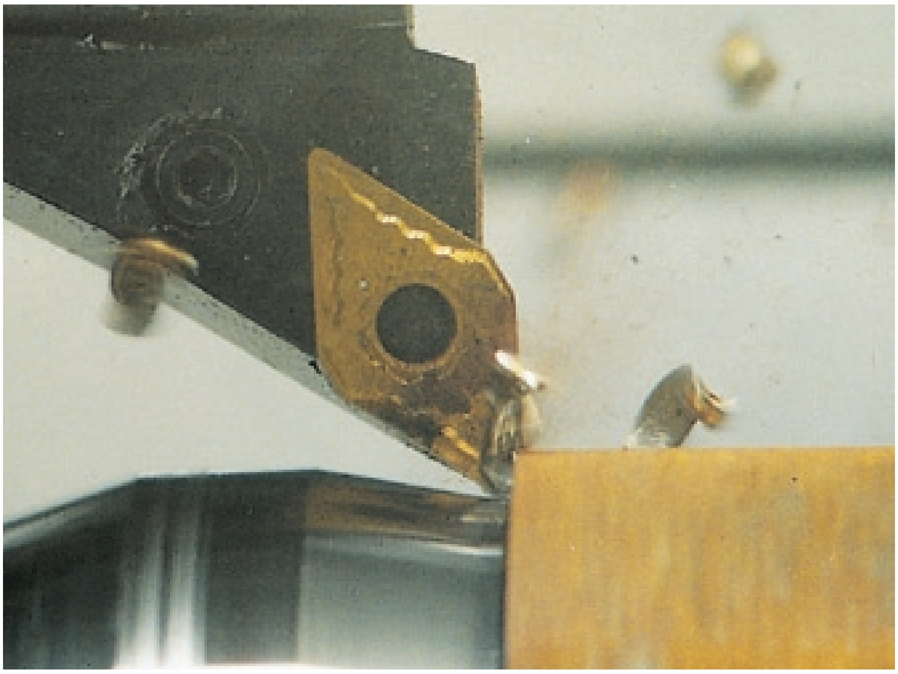
T-MAX P clamping systems

T-MAX P

T-Max P clamping systems use negative single and double sided inserts which comply with ISO standard.
The different designs are described below.

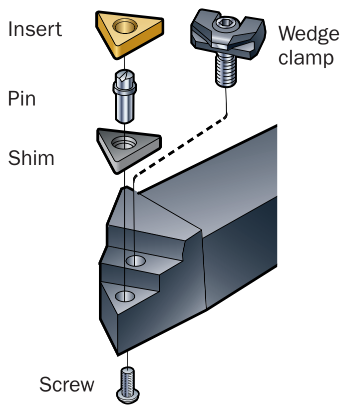
Lever design



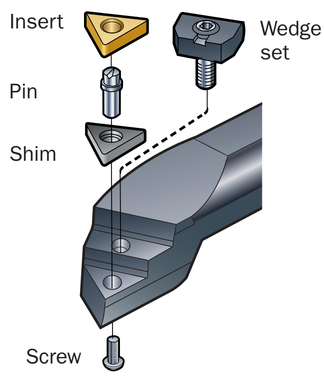


Available tools:
- Shank holders
- External and internal Coromant Capto cutting units
- Bars
- Exchangeable cutting heads (570)
- Cartridges

Wedge clamp design



Wedge design



Available tools:
- Shank holders
- External and internal Coromant Capto cutting units
- Bars

Note!
Wedge clamp and wedge design are fully interchangeable between each other without modification.

CoroTurn 107 screw clamping system

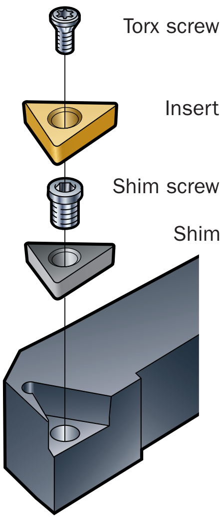
CoroTurn 107 is our successful screw clamping system using positive inserts mainly in small tools. The advantages over the top clamp system in this area are stability, chip flow and the possibility to use a large variety of insert shapes.

Quality

Considerable effort has been put into the CoroTurn system to meet the tolerance demands on offsets, inserts, insert seats and screw tolerances. The copying tools with DCMT and VBMT inserts have been reinforced for better stability to eliminate any risk of insert movement.

CoroTurn 107 is the first choice for turning externally and internally with positive inserts.

CoroTurn 111 is the choice for optimizing internal machining with positive inserts.



Available tools:
- Shank holders
- External and internal Coromant Capto cutting units
- Bars
- Cartridges

A
B
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Clamping systems for ceramic and cubic boron nitride (CBN) inserts

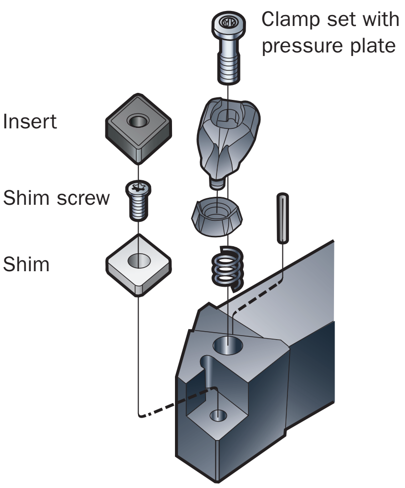
CoroTurn RC rigid clamping system

Top and hole clamping
Good, stable clamping is essential if the maximum metal cutting potential of ceramic and CBN inserts is to be utilized to the full. Coromant's CoroTurn RC holders have been designed for the specific needs of such materials.

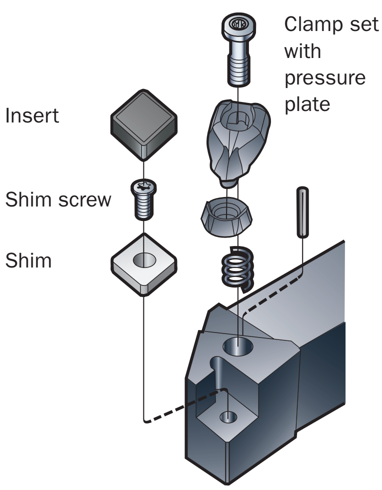
CoroTurn RC is therefore the first choice system for clamping ceramic and CBN inserts.

[1] It is possible to transform a CoroTurn RC standard tool for cemented carbide inserts into a tool for ceramic inserts by changing the clamp set and shim.

Holder for insert with hole



Holder for insert without hole



Available tools:
- Shank holders
- External Coromant Capto cutting units
- Bars[1])
- Cartridges[1])

A
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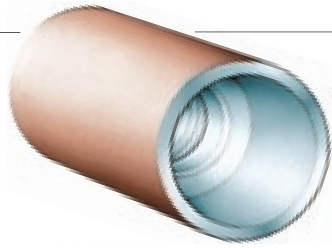
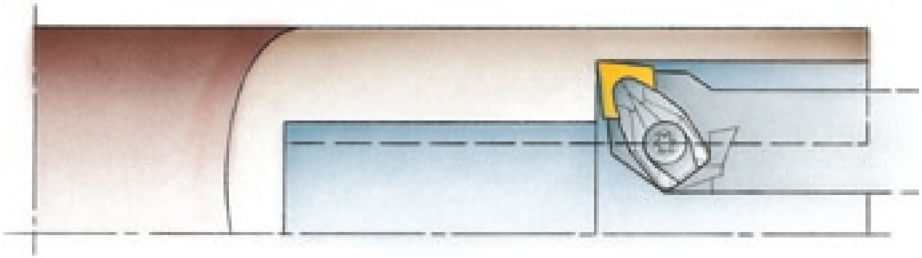
Internal turning





Tool overhang is the most prominent factor in boring operations.

Boring

Most of the turning operations which are classed as external turning are also to be found in boring, as performed with stationary turning tool, (as opposed to boring operations with rotating tools, such as in machining centres). With external turning, the tool overhang is not affected by the length of the workpiece, and the size of the tool holder is selected to withstand the forces and stresses which arise during the operation. With boring - internal turning - the choice of tool is very much restricted by the component's hole diameter and length, as the depth of the hole determines the overhang.

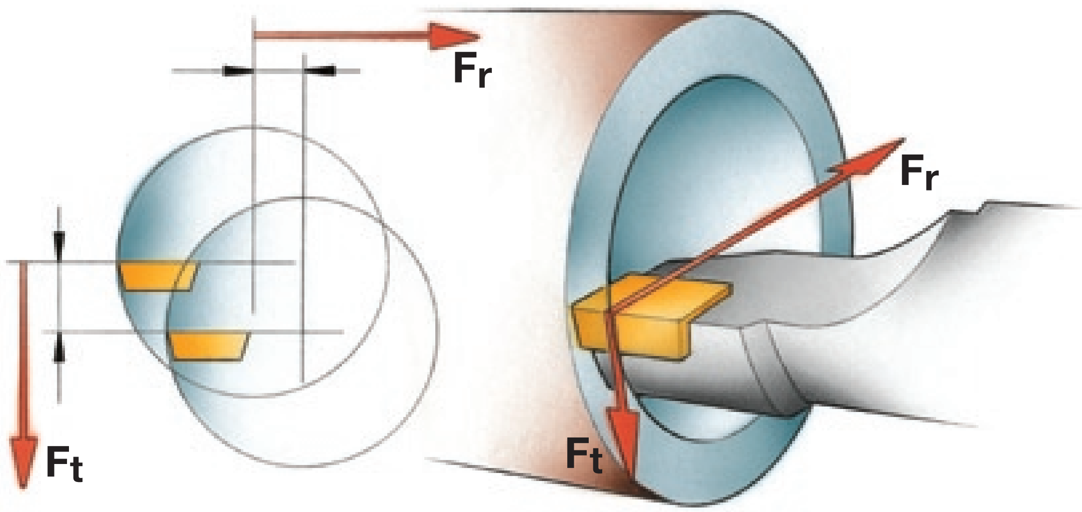
A general rule, which applies to all machining is to always minimize tool overhang and to select the largest possible tool size in order to obtain the best possible stability and thereby accuracy. The stability is increased when a larger boring bar diameter is used, but possibilities are often limited, since the space allowed by the diameter of the hole in the component must be taken into consideration for swarf evacuation and any radial movement.

The limitations with regard to stability in boring mean that some extra care must be taken with production planning and preparation. Selecting the right boring bar for the operation, applying it correctly and clamping it properly has considerable effect on keeping tool deflection and vibration to a minimum, and consequently the quality of the hole being machined.

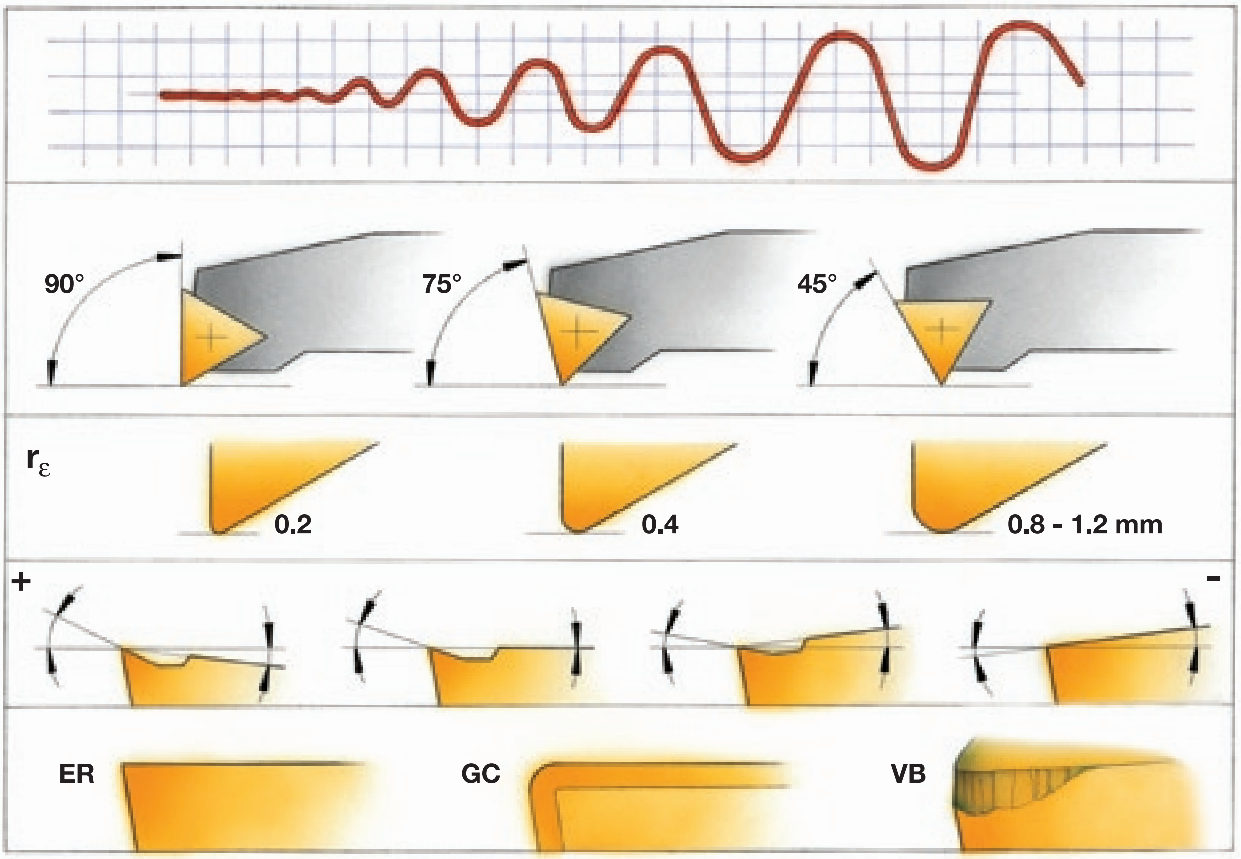
Cutting forces in boring operations

When the tool is in cut, a tangential cutting force and the radial cutting force will endeavour to deflect the tool away from the workpiece.

The tangential force will try to force the tool downwards and away from the centre line, in so doing it will also reduce the tool clearance angle. When boring small-diameter holes, it is particularly important that the clearance angle of the insert is sufficient in order to avoid contact between tool and wall of hole.



Radial and tangential cutting forces deflect the boring bar during machining, often necessitating cutting edge compensation and tool damping.



Factors that affect vibration tendencies positively and nagatively. Vibration tendencies grow twoards the right.

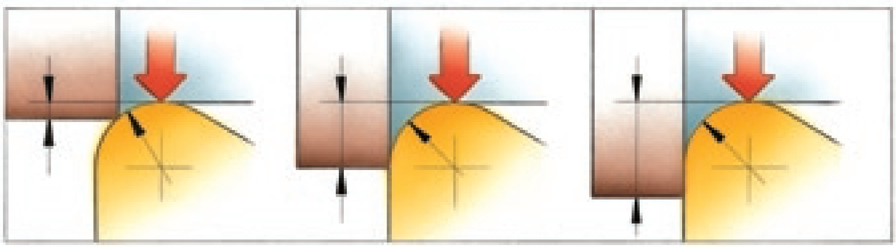
Any radial deflection means that the cutting depth as well as the chip thickness is reduced, which can lead to vibration tendencies. The stability of the tool and clamping will then be crucial as to the magnitude of the vibration and whether this is amplified.

The geometry of the insert has a decisive influence on the boring process because a more positive geometry means a lower tangential force.

The entering angle of the boring tool affects the direction and magnitude of axial and radial cutting forces and the resulting deflections. A large entering angle produces a large axial cutting force component while a small entering angle results in a larger cutting force in the radial direction. However, the axial cutting force does not normally have a large effect on the operation since the force is directed along the boring bar. It is advantageous therefore to choose a large entering angle. It is also recommended that the entering angle be as close to 90 degrees as possible and never less than 75 degrees as this means a dramatic increase in the magnitude of the radial cutting force.

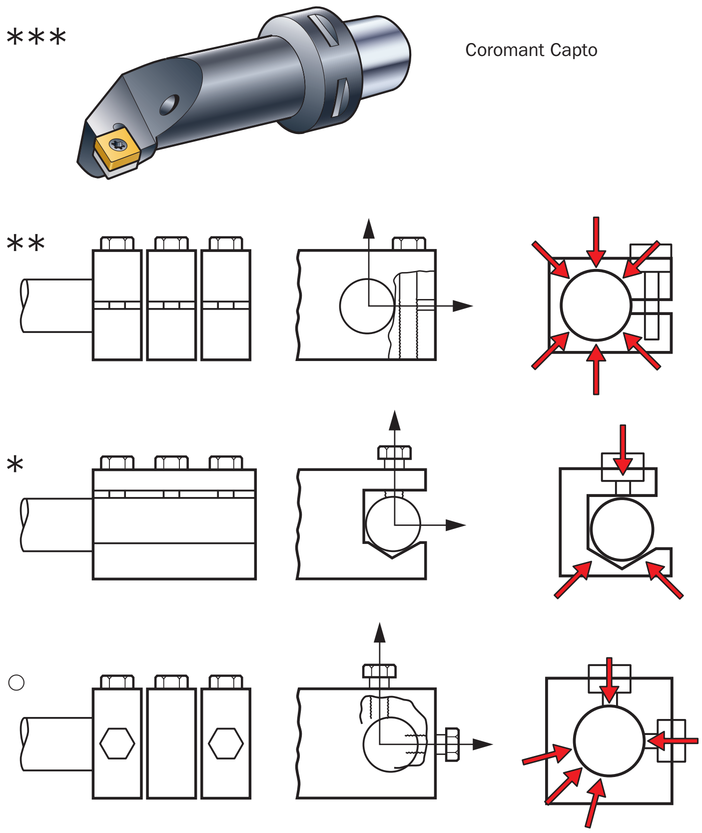
Generally in boring, a small nose radius should be first choice. The larger the nose radius, the larger will be the radial and tangential cutting forces and the risk of vibration. The deflection of the tool in a radial direction on the other hand is more affected by the combination between the cutting depth and the size of the nose radius. With a small relationship between the cutting depth and nose radius, the radial cutting forces will increase with increased cutting depth. As soon as the cutting depth is the same or greater than the size of the nose radius, the radial deflection will be determined by the entering angle.

A rule of thumb is to choose a nose radius which is somewhat less than the cutting depth. In this way the radial cutting forces can be kept to a minimum while utilizing the advantages of the largest possible nose radius leading to a stronger cutting edge, better surface texture and more even pressure on the cutting edge.



The relationship between nose radius and DOC affects vibration tendencies. It is often an advantage to choose a nose radius which is smaller than the D O C.

The edge rounding (ER) of the insert may also affect cutting forces. In general, uncoated inserts have smaller edge rounding than coated ones (GC) and this should be a consideration especially with large tool overhangs and small holes. Excessive flank wear (VB) on the insert changes the clearance between tool and hole wall and this can also be a source which affects the cutting action of the process.



The way a boring bar is clamped is decisive as regards performance and results
(*** = best, ** = acceptable, * = unacceptable, ○ = not recommended.)

Holding the boring bar

The boring bar deflection is dependent on the bar material, the diameter, the overhang, the size of the radial and tangential cutting forces and the bar holding in the machine. The slightest amount of movement at the clamped end of the boring bar will lead to deflection of the tool. Modern high-performance boring tools deserve to be clamped with high stability so as not to introduce a weak link in the set-up. To start with, it is important that the internal surfaces of the tool clamping arrangement are clean and have high surface finish and sufficient hardness.

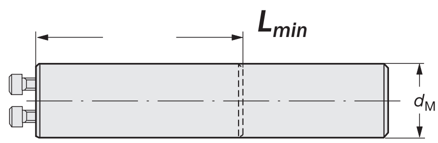
The optimum stability-solution for clamping the boring bar is a Coromant Capto integrated tool. For conventional boring bars, solid support is always better than screws acting on the bar, as these may damage the bar. Tuned boring bars should never be clamped by screws. The best stability is obtained with a holder which completely encases the bar. A V-type bar-holder with screws may be adequate but a cylindrical holder with screws is not recommended.

It is important that the recommendations for length, surface finish and hardness of the clamping of the boring bar are met. The adjoining minimum values are primarily intended for use with tuned boring bars but can be seen as general guidelines. The clamping of the boring bar is a critical stability factor.

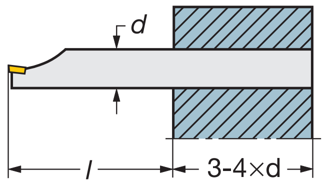
To modify a standard boring bar to suit an application, the simplest form of adaption is to shorten a standard bar. As regards tuned bars, the length that can be cut off is limited according to the table. When cutting off a boring bar, the minimum clamping length should not exceed 3 times the bar diameter.

All boring bars have through-tool coolant supply via slots, on bars having diameters of 16 to 25 mm and through holes on the 32 to 60 mm range.

CoroTurn SL (570)



Bar diameter dm_m	Design 570-3C Short	Long
16	100	-
20	120	-
25	145	199
32	190	280
40	220	335
50	250	380
60	300	458

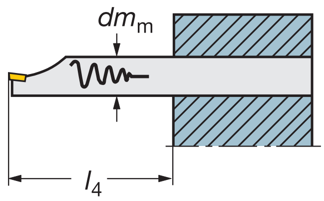


Solid bars

Smallest possible overhang

Max recommended overhang for steel bars 4xD (*l*)

Max recommended overhang for Carbide bars 6xD (*l*)



Tuned damped bar

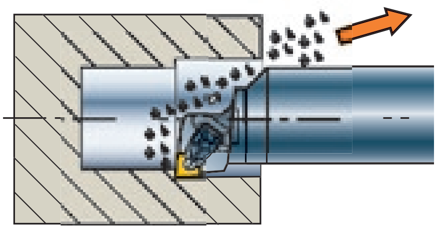
l_4 = damped part.

Do not clamp in this area. This is indicated on the boring bar.

Max recommended overhang for damped bars, short design 7xD and long design 10xD.

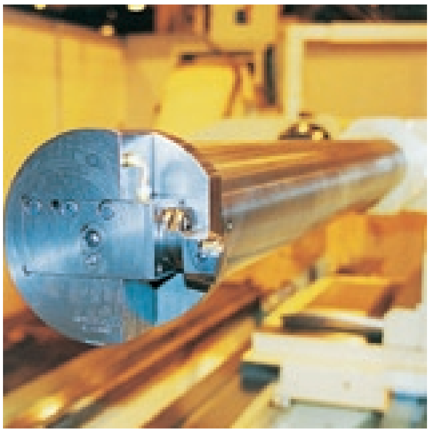
Chip evacuation during boring is critical to performance and the security of the operation. Relatively short, spiral shaped chips should be aimed for with internal turning. These are easy to evacuate and do not place such large stresses on the cutting edge when chipbreaking occurs. Hard breaking of the chips, when very short chips are obtained, is more power demanding and can increase vibration tendencies. On the other hand, long chips make chip evacuation more difficult and presents a risk of swarf-clogging. It is thus necessary to choose an insert geometry which, together with the chosen machining parameters, fulfil the requirements for good chip control.

When internal turning is undertaken, the chip flow can be critical - particularly when deep holes are being machined. The centrifugal force presses the chips outwards and, with internal turning, this means that the chips remain in the workpiece. The remaining chips can be pressed into the machined surface or get jammed and damage the tool. Therefore, with internal turning, tools with an internal cutting fluid supply are recommended. The chips will then be flushed out of the hole effectively. Compressed air can be used instead of cutting fluid and, with through holes, the chips can be blown through the spindle and collected in a container.



Chip evacuation is a critical factor for successful boring.

A long tuned boring bar on a flat-bed lathe.



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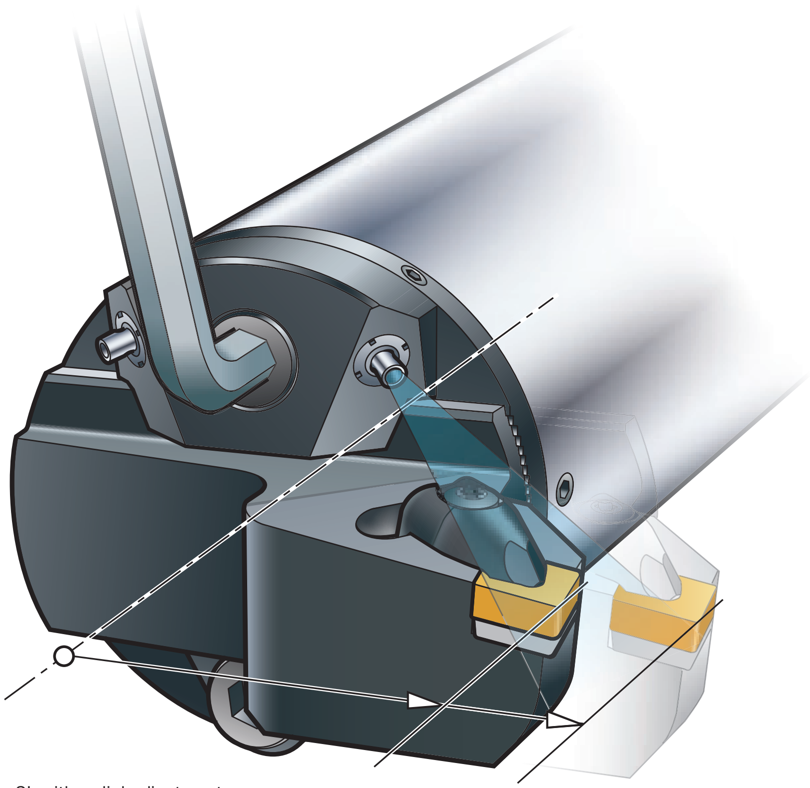
Boring very deep holes

The internal machining of large diameter holes, deep holes and a combination of both usually needs tool solutions where stability during machining is maximized through combinations of tool solutions. In addition to basic points (such as maximum bar diameter, sufficient chip evacuation, positive insert geometry, 90 degree entering angle, correct insert shape, small nose radius and sharp cutting edge), special tool features may need to be considered to provide the boring bar with every weapon there is against vibration tendencies, especially when tolerances are close and surface finish is an issue.

Stability starts at the back end, where the boring bar is clamped in the machine. Coromant Capto or complete encasement of the bar in a sleeve should always be the case.

When discussing tool overhangs of 10 times the diameter or more, tuned boring bars and carbide re-inforcement should be considered or a combination of both. The cutting unit coupling is a critical link and needs to be beyond any risk of instability. The front end should also be characterized by low weight. This means that if there is a scope for diameter reduction of the cutting unit or the last bart of the bar, this is worth considering. It is the back end and the main part of the boring bar that should be as large as the operation permits – even tapered bars are suitable for some applications.

The CoroTurn SL (570 coupling) provides the means for high stability, diameter reduction, quick change of cutting unit and radial adjustment of the cutting edge (f1 dimension). Bar diameters of over 40 mm have adapters which reduces the coupling to accommodate the large 40 mm diameter range of cutting units.



CoroTurn SL with radial adjustment.

Tool clamping at the front end and back end are important performance factors for machining with long boring bars.

Eliminating vibration tendency with tuned boring bars

The usual cause of vibration during machining is the dynamic interaction between the cutting process and the machine tool structure. The source is the variation of cutting force generated between the tool and workpiece. This force strains the structure elastically and can cause a deflection of the tool and workpiece, which alters the tool-work engagement. A disturbance in the cutting process, such as a hard spot in the work material, causes a typical deflection which then alters the cutting force. There may then be a possibility for the initial vibration to be self-sustaining and to build up with the machine oscillating in one of its natural modes of vibration. A long boring bar overhang can be a weak link in the set-up involving machine tool – tool – workpiece and a source of vibration.

In order to achieve sufficient process stability, the metal removal rate is often reduced or the cutting tool changed. But as productivity is normally a priority in manufacturing, this is the wrong route to go. Instead the means of eliminating vibration and being able to machine at higher rates should be examined. The use of tuned boring bars, with integrated damping elements, improves the dynamic behavior of the tools, making the process more stable.

Generally, machining up to four times the diameter of boring bars does not cause any problems from the vibration point of view, provided that correct conditions apply as regards cutting data and inserts. With an overhang of more than 4 times the tool diameter, vibration tendencies can become more apparent and tuned bars come into the picture as the solution. With a pre-tuned boring bar, machining of holes with a depth of up to 14 times the diameter of the bar can be performed with good results.

An increased length from 4 to 10 times the bar diameter will give a 16 times larger deflection for a bar being subjected to the same cutting force. A further extension from 10 to 12 times the bar diameter, gives another 70 % increase in deflection from the same cutting force. Holding the bar length constant while changing the bar diameter from 25 to 32 mm, reduces deflection by 62% for equal cutting forces. Reducing the weight of cutting units or the diameter at the front end of the bar will also contribute towards minimizing vibration.

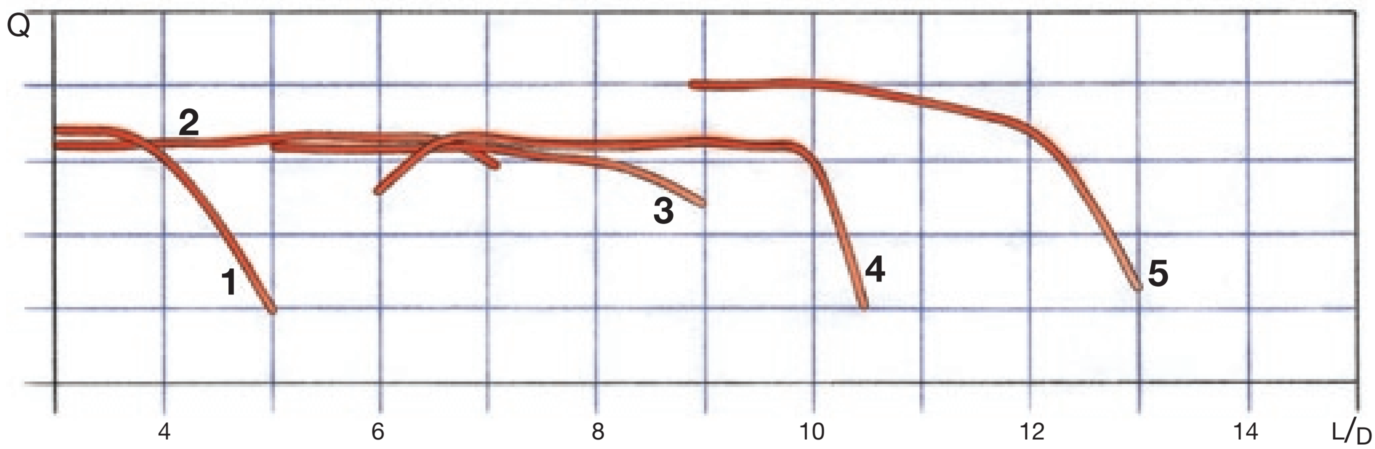
Tuned boring bars – Silent Tools - includes tools that are pre-tuned to the correct frequency in relation to the tool length. This means basically setting up the tuned boring bar and the machine to be set up as would a conventional, solid boring bar.

The pre-tuning system of the tuned bar consists mainly of a heavy tuning body (A) with a certain inertia mass, suspended in two rubber bushes (B), on at each end of the tuning body. The tuning body is surrounded by a special oily liquid (C). If vibration tendencies should arise during the machining process using a tuned bar, the dampening system will immediately come into force, and the movement-energy of the bar will be absorbed in the tuning system. As a result, vibration is minimized and machining performance maintained or improved.

The main parts of a tuned boring bar are:
A : heavy tuning body,
B : rubber bushes,
C : special oily liquid.

1. Solid steel bar
2. Carbide alloy bar
3. Short, damped bar
4. Long, damped bar
5. Extra long, damped bar

Q = metal removal rate (cm³/min)



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