# Common problems in milling and solutions

Main points of solution and inspection			Sele of t mat	Selection of tool material						Tool shape							Machine clamping system			
	F	Failure	Material with higher hardness	Material with perfect toughness	Cutting speed	Feed rate	Cutting depth	Change the diameter and width of milling tools	Cutting liquid	Rake angle	Approach angle	Strength of cutting edge	Number of teeth	Increase the width of chip pocket	Examine the geometry shape of Minor cutting edge.	check the end face run-out	Improve the rigidity of tool	Clamping system of workpiece	Overhang of tool	Power, gap
Fracture of tool nose	severe abrasion	Improper cutting condition			ţ				✓											
	clearance face	Unsuitable geometry shape of cutting edge	~							1		t								
	severe abrasion on rake face	Improper cutting condition			ţ	t	t		✓											
		Unsuitable geometry shape of cutting edge	✓							1	ţ	ţ								
	Fracture of cutting edge	Improper cutting condition				t	ţ													
		Unsuitable geometry shape of cutting edge		✓							ţ	1			✓	✓	✓	~	<ul> <li>Image: A start of the start of</li></ul>	✓
	Thermal cracking	Improper cutting condition			ţ	t	t		✓											
		Unsuitable geometry shape of cutting edge								1		t								
	Build-up edge	Improper cutting condition			1	1			✓											
		Unsuitable geometry shape of cutting edge								1		ţ								
	Bad surface roughness	Abrasion of tool Great vibration of milling tool	✓		1	ţ	t		✓			ţ			Wiper	✓				
Mac	Burrs occuring	Unsuitable geometry shape of cutting edge			ţ	t	t	✓												
hining precision		Improper geometry shape of cutting edge								1	1	t			✓					
	Side collapse	Unsuitable geometry shape of cutting edge				t	t													
		Unsuitable geometry shape of cutting edge								1	ţ	ţ	1		✓		✓			
	Planeness and parallelism deterioration	Improper geometry Improper technique				t	t			1	1		t		~	✓	~	✓	✓	✓
Other	Vibration	Cutting condition Improper technology			ţ	t	t	✓		1	1	t					✓	✓		~
	Chips twisting	Improper cutting condition			1	†↓		✓	✓				ţ							
	and jamming	Unsuitable geometry shape of cutting edge								1			1	✓						

### Difference and selection between down milling and up milling



**Climb milling (also called down milling)**: the feed direction of workpiece is the same as that of the milling rotation at the connecting position. **Conventional milling (also called up milling)**: the feed direction of workpiece is opposite to that of the milling rotation at the connecting position.

In down milling, the major force of cutting edge is compressive stress, while in up milling the tensile stress. The compressive strength of cemented carbide material is much larger than its tensile strength. In down milling, as chips become thin from thick gradually, cutting edge and workpiece press against each other. The friction between edge and workpiece is small, thus reducing the abrasion of edge, the hardening of workpiece surface and the surface roughness (Ra). In up milling, chips become thick from thin gradually. When the insert is cutting into the workpiece, it produces strong friction and more heat than in down milling, and make workpiece surface hardened.

In up milling, because horizontal direction of cutting force milling cutter conducting on workpiece is opposite to the feed direction of workpiece, the lead screw of worktable joints closely with one side of the screw nut. In down milling, the direction of cutting force is the same as the feed direction. When edge's radial force on workpiece is large enough, the worktable will bounce left and right, thus make the gap fall behind. The gap will return to the front side with the continuing rotation of lead screw. At this moment the worktable stops motion, however, it will bounce left and right again when the radial cutting force is large enough again. The periodical bounce of worktable will cause poor surface quality of workpiece and tool breakage.

When using end mills for down milling, the edges always starts cutting at the workpiece surface, therefore end mills are not suitable for machining workpiece with hardened surface.

Up milling is recommended for milling thin-wall components or square milling with high requirement for precision.

## Pitch selection

Pitch is the distance between one point on one cutting edge and the same point on the next edge. Milling cutters are mainly classified into coarse, close and extra close pitches.



## Selection of approach angle

The approach angle is formed by insert and tool body. It affects chip thickness, cutting forces and tool-life. Decreasing the approach angle reduces chip thickness and expands the cutting area between cutting edge and workpiece at a given feed rate.

A smaller approach angle also ensures stable entry into or exiting workpiece, protecting the cutting edge and extending tool life. However, this will increase axial cutting forces on the workpiece, thus is not suitable for machining thin workpiece such as thin plate.

Approach angle	Feed rate per tooth	Real maximum cutting depth
90°	$f_Z$	$h_{ex}=f_z \times sinkr$
75°	$f_Z$	$h_{ex}=0.96 \times f_z$
60°	$f_Z$	$h_{ex}=0.86 \times f_z$
45°	$f_Z$	$h_{ex}=0.707 \times f_z$
Round insert	$f_Z$	$h_{ex} = \frac{\sqrt{i C^2 \times (i C - 2 a_p)^2}}{i C} \times f_z$

 $V_f$  : feed rate of worktable (feed speed)(mm/min)

 $f_z$ : feed rate per tooth(*mm/z*)

**Technical information** 



 $V_c$ : cutting speed(*m*/*min*)

 $D_c$ : nominal diameter of milling tool(*mm*)

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# Function of each part in face milling



### Main angles of face mills

Designation	Function	Effect					
Axial rake angle <i>rf</i>	Determining the chip direction	Negative angle, excellent capability of chip removal					
Radial rake angle $r_p$	Determining whether the cutting is easy and fast or not	Positive angle: good cutting performanc					
Approach angle Kr	Determining the chip thickness	Kr † , chip thickness † ; $Kr$ ↓ , chip thickness ↓ ;					
Rake angle <i>R</i>	Determining whether easy and fast the cutting is or not	Poor cutting performance, High-strength cutting edge	(−)←0→(+)	Good cutting performance, Low-strength cutting edge			
Inclined angle of cutting edge $\lambda s$	Determining the chip flow direction	Poor capability of chip removal, High-strength cutting edge	(−)←0→(+)	Good performance of chip removal, Low-strength cutting edge			



### Characteristics of different rake angles combined

### Cutting performances of different approach angles

Approach angle	45°	75°	90°
Schematic diagram			
Instruction	Axial force is the largest. It will bend when machining thin- wall workpiece, reducing the precision of workpiece. It can help avoid fringe breakage of workpiece when machining cast iron.	The main force is radial cutting force. It is often used in general face milling.	The axial force is zero in theory, suitable for milling thin plate workpiece.





### Selection of cutting width and tool cutting diameter in face milling



Dc: Tool cutting diameter ae: Cutting width

Generally speaking, the relation between cutting width and tool cutting diameter is Dc=(1.2-1.5) ae. In practical machining, same center line of

tool center and work piece center should be avoided.