Failure of tool holder in Grooving operation at different working conditions.

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Abstract- This paper presents determination forces in grooving operation, while orthogonal cutting. However, compared with general cutting, grooving is subject to problems such as difficulty in chip evacuation, which can result in defects on metal surfaces, tool vibration and tool holder failure, due to the high load operation with the entire cutting edge. To improve processing efficiency and accuracy while minimizing the cost of grooving tools, and tool holders. The first consideration is configuring a cutting tool system that will produce the desired part shape. As a result, the designs of grooving tool and grooving tool holders systems vary according to the size and depth of the features being machined. For deep grooving and parting-off operations on large parts, as well as for shallow grooving and cut off on smaller parts, tool manufacturers, for instance, will offer on-edge or tangential-configuration parting-off and grooving inserts that are clamped directly in a holder. The inserts' tangential design directs cutting forces into the holder to maximize rigidity, stability and productivity. A zero-degree lead angle tool provides perpendicular alignment to the work piece and transfers cutting forces directly into the tool holder, which enhances accuracy, tool life and surface finish. It reduces tool failure but at the same time increases tool holder damage chances. To understand the failure pattern ,different forces have to be determine, So grooving tool holder design is one of the important aspect, we can perform FEA method to determine grooving tool holder failure under certain loading.

Index terms- Grooving operation, Grooving tool holder, orthogonal cutting,

1. INTRODUCTION

Grooving is the multistep machining operation .it is a process of forming a narrow cavity of a certain depth, on a cylinder, cone or face of a part. Groove will be in the shape of the cutting tool.

Machining grooves has many similarities to parting off, especially deep grooves. Although the same tool holder systems can be used for both parting and grooving in many instances, the insert geometries are dedicated to provide optimum performance and results. Grooves vary; there are shallow grooves, deep grooves, wide grooves, external grooves, internal grooves and face grooves. For single grooves, a suitable insert is applied to match the size and limits while wider grooves can be machined in various ways. Dedicated insert geometries, for low and high feed applications, contribute towards optimizing the grooving operations by giving specific benefits. [1]

1.1 Types of grooving process

1.1.1 Face grooving

Making grooves axially on the faces of components requires tools dedicated for the application. A face grooving tool has to be made to clear the round groove which it is making the tool holder has to be curved. Both the inner and outer diameter of the groove needs to be taken into account for the tool to be accommodated. First-cut diameter ranges are indicated for various tools. When a groove is machined in several cuts, only the first cut needs to be considered as the tool is then accommodated to machine smaller groove diameters. . For face grooving, the following general points apply:

- minimize tool overhang to limit any vibration tendencies
- keep the in feed rate low during the first cut to avoid chip jamming
- start machining the largest diameter and work inwards to obtain the best chip control
- if chip control during first cut is unsatisfactory, dwelling can be introduced [1]

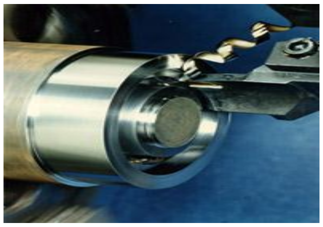

Fig.1. Face grooving

1.1.2 Circlip grooving

The need for circlips on shaft and axle components is very common and there are two systems suitable for these operations. Both systems have specific widths for circlip grooves. . First choice is the three-edge T-Max U-Lock 154 system with groove widths of 1.15 to 4.15 mm for external and internal There is a tool cost advantage with the 3 cutting edges. Second choice is the CoroCut 2 system using the GF insert geometry with widths 1.85 to 5.15 mm for external applications. Undercutting Recesses for clearance, such as for subsequent grinding operations on various shafts and axles, require dedicated inserts with round cutting edges that are sharp and accurate. For this there are small and large applications. For the shallow recesses, CoroCut 1 or 2 with RO and RM insert geometries are recommended. For deeper recesses, T-Max Q-Cut system with insert geometry 4U is recommended.[1]

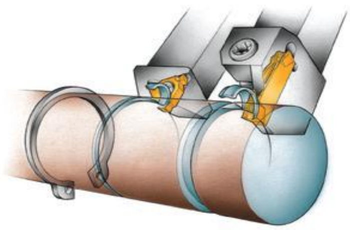

Fig.2. Circlip grooving

1.1.3 *Internal grooving*

Most of the methods for external grooving can be applied to internal grooving. Precautions may have to be considered, as with boring in general, to ensure chip evacuation and to minimize vibration tendencies. Tool size, overhang and set-up should be optimized and tuned bars be a possible solution, especially when the tool overhang is 3-7 times the tool diameter. CoroCut SL is a good solution where tool assemblies can be made to optimize the application. Solid and tuned adaptors are available within the SL-system. CoroCut with dedicated insert geometries GF, GM, TM and TF are suitable for internal grooving For smaller holes (diameters below 25 mm) the T-Max Q-Cut 151.3 system with insert geometry 4G is recommended. Multiple grooving or plunge grooving, especially with narrow inserts, reduces vibration tendencies when making wide grooves. Finishing operations can then be performed separately. Chip evacuation is facilitated by starting machining at the bottom of the hole and machining outwards. Use the best choice of right- or left-handed insert to direct chips especially in roughing.[1]

Fig.3. Internal grooving

2. GROOVING TOOL HOLDER

Grooving tool holders has so much importance in parting and grooving processes, due to its rigidity and versatility. Grooving operation is totally depend upon the type of groove and parting operation.

2.1 Types of grooving tool holder

Grooving tool holder is mainly divided into two types, i.e right handed tool holder and left handed tool holder. When some special type of operations is going to perform on work piece then special shape of holder is used. It consists of different shape of ER (seat of insert). It may also be depend upon rake angle of insert and depth of cut.

2.1.1 Right handed tool holder

Right handed tools are those, which when rotate clockwise direction then it may cut the metal.

Fig.4. Right handed tool holder

2.1.2 Left handed tool holder

Left handed tools are those, which when rotate counterclockwise direction then it may cut the metal.

Fig.5. Left handed tool holder

2.1.3 Special type tool holder

Special type of tool holders is used where chances of damage of tool holder and insert are more, than regular practice. These types of tool holder contain special shape of ER to remove chips from working area. When complex shape of groove is to be cut then position of insert is varied.

In many cases, due to insert failure tool holder gets damage and it costs more. In those cases removable holder jaws are preferred. When damage occurs then only jaw get affected. It reduces cost of failure.[2]

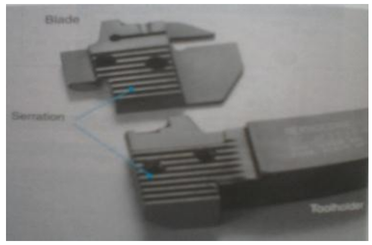

Fig.6. Special type tool holder

3. INSERTS

At the beginning of a cut the insert will work at a relatively high cutting speed, and must be able to resist plastic deformation. The speed reduces as the tool approaches the center, at which point it becomes zero. Modern machines can be programmed so that the spindle speed is automatically increased towards the center, so that the cutting speed is kept constant. But the maximum spindle speed of the machine will be reached before the tool reaches the center, and this could result in insert edge build up. Therefore, a tough tool material will be needed to resist edge build-up as the tool gets closer to the center. Advanced insert geometries are necessary for performing parting and grooving operations in a satisfactory way.

3.1 Inserts specifications

- Insert is recognized by its size i.e. 3mm, 5mm, etc. It is represented by (t).
- Another important parameter is clearance angle of insert. It is denoted by (α)
- Last important parameter is chip breaker type. [2]

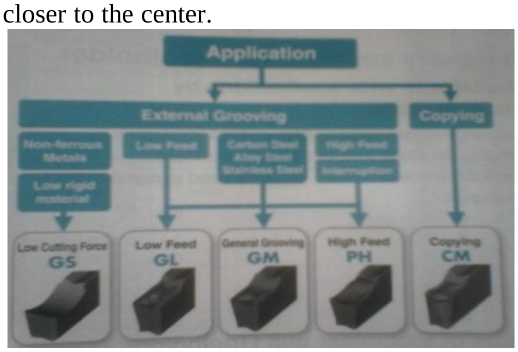

Fig.7. Types of chip breaker

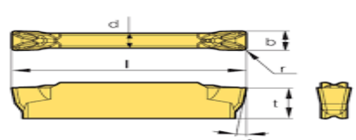

Fig.8. Inserts specifications

4. FAILURE OF TOOL HOLDER

Failure of grooving tool holder is a common phenomenon in Grooving operation. Mainly it happens due to improper insert working and cutting force.

Fig.9. Failure of tool holder

4.1 Causes of failure of holder

4.1.1 Insert setting

This is one of the main causes of tool holder failure. If insert is not placed properly at its seat, then it causes problems in chip removal. And chip removal directly affects the life of insert and so as holder.

4.1.2 Improper working conditions

Improper working conditions includes

- High feed rate
- High depth of cut
- High cutting velocity.
- Wrong material selection of holder and insert.

If above working parameters are more or less than recommended values then there are maximum chances of tool holder failure.

4.1.3 Chip removal

Chip removal is most important aspect of cutting. In grooving operation there is so narrow space available for chip removal. When chips are not continuous then this gap is filled by fragments of chips. It reduces the insert efficiency drastically. So to avoid damage of both holder and inset, removal of chip should be proper.

4.1.4 Excessive force

Cutting force is major component in force system. It is denoted by F_C. Total amount of cutting force acting on tool tip is near about 70 to 80 % of total force. It means that, if cutting force increases then failure chances increases. [5]

5. FORCE CALCULATIONS

The determination of the mathematical relationships used to calculate the cutting forces was achieved by means of SKZ – a software application developed at the Institute of Machine Tools and Production Engineering of the Lodz University of Technology. First, the above–mentioned software was fed with input data (VC, *f*, r€) from a text file prepared beforehand and the form of the regression function was selected (Y1 = B0 + Sum (Bi * Xi)).
The final function of the object of our analysis took the following form. [3]

FC=CF.$f.^{ff}$r€^{fr}.V_c^{fv} [N]……………………………Eq(1)

Where:

F_C	=	Cutting force	[N]
F	=	Feed	mm/rev
r€	=	Corner radius of insert	mm
V_C	=	Cutting velocity	mm/min

Constants	value
C_F	244996
f^f	0.677
f^v	-0.363
f^r	-0.919

(for dry machining)[3]

6. CONCLUSION

When parting and grooving the inserts are often fed deep into the material, which sets high demands on accessibility. This means that the tools used are generally narrow and therefore the length of the tool increases as the diameter increases. Tools and tooling systems with high stability is therefore important.[1]

Hence by above discussion we can say that tool holder failure can be prevented by following ways

- Best insert selection
- Best chip breaker selection
- Better insert position
- Better chip removal
- Moderate working conditions like feed, depth of cut, cutting velocity.

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