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"Design and Analysis of Table for Micro Milling"

[1]R R Honkalas., [2]P M Pawar., [3]B P Ronge.
[1] ME Student, Dept.Of Mechanical Engg. SVERI's COE, Pandharpur.
[1]Dept.Of Mechanical Engg. NBN Sinhgad COE, Solapur.
[2]Dept.Of Civil Engg. SVERI's COE, Pandharpur
[3]Dept.Of Mechanical Engg. SVERI's COE, Pandharpur

Abstract:

Micro-milling is a traditional milling process that has been scaled down to micron level. However due to the small diameter tools used in the process, micro-milling is significantly different than conventional milling in a variety of factors, viz. cutting forces, tool run-out, metal removal rate, table/bed movement etc..

Micro-milling is an enabling technology that may allow rapid and economic fabrication of meso-scale components with micro-scale features. At present stage, the activities of design, development and manufacturing of micromachine tool in India it at preliminary state. There is a huge gap exist between the technology available abroad and Indigenous. This identifying the need study of different parameters which affects the performance as well the accuracy of micro milling machine. This study gives the methodology for improvement accuracy as well performance of micromilling machine Table.

Keywords: Micro, Milling, Micron, meso-scale etc.

Introduction:

Current trends of industrial scenario put tight requirement on components and newly put following challenges.

1. Miniaturization of machining and components.
2. Machining new materials like ceramics and HSAS etc.
3. Components integrity
4. Preciseness.

There is a continuous demand for miniaturization of components for consumer and other products. Micro-milling is a potential technology for the production of miniaturized parts and components. There exists a wide variety of important applications for micro and meso-scale mechanical systems in the commercial and defense sectors, which require high-strength materials and complex geometries that cannot be produced using current MEMS fabrication technologies. Micro-milling has the potential to fill this void in MEMS technology by adding the capability of free form machining of complex 3D shapes from a wide variety and combination of traditional, well-understood engineering alloys, glasses and ceramics. At present stage, the activities of design, development and manufacturing of micromachine tool in India it at preliminary state. There is a huge gap exist between the technology available abroad and Indigenous. This identifying the need study of different parameters which affects the performance as well the accuracy, Increasing standard of machine tool performance means that machine tool developers are expected to not only concentrate on optimization of the machine tool itself in terms of the maximum speed and the precision of machine axes, but also take full account of machining processes. In other words, the machine tool developers now have to take responsibility for the overall machine's performance characteristics Therefore, when designing precision machines, it is essential to consider the interaction among the mechanical structure, control system dynamics, and machining process dynamics at an early stage.

While studying the literature available on Micro Milling, there was very few scope are given to the mechanical structure required for the machine. The mechanical structure like machine frame, machine bed / table, required housing to support the structure. Machine table is one of the important components of every machine, here also it is major. So there is a need of detail study of the table especially for micro milling.

MicroMilling: The development of miniaturized technologies has become a global phenomenon with applications in diverse fields and industries including telecommunications, portable consumer electronics, defense, and biomedical. One technology used to create these miniaturized components is micro milling. Coupled with sophisticated CAM software micromilling produces complex 3 dimensional topographies with the precision of few microns.

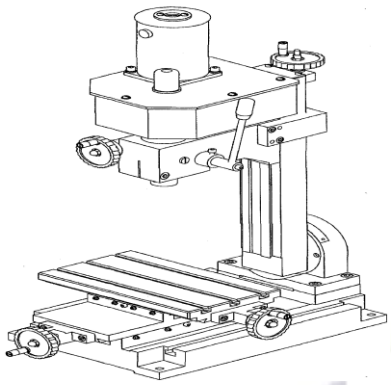

Fig.1. Micromilling Machine

Performance affecting Parameters of Table:
Following are the various categories of affecting parameters through performance as well accuracy of table for micro milling machine will be affects.

A. Direction of Motion of sliding:
- Straight Line Guides
- Circular Guides

B. Shapes of Guides:
- Flat Guide
- Conical Guide
- Combination Guide
- Dovetail guide
- Cylindrical Guide

C. Material:
- C.I
- Steel
- Plastic
- Reinforced Concrete

D. Frictional Behavior:
- Sliding Friction
- Rolling Friction

a. Recirculating Ball Screw

1. Profile of Thread
2. Surface Finish
3. Material Use

- Combination of rolling and sliding friction.

E. System of Lubrication:
- Boundary
- Hydrodynamic
  a. full
  b. partial
- Hydrostatic
  a. Up to partial pressure
  b. Above critical pressure
    - Lubrication Free

F. Construction:
- Fabricated or Welded
- Integral construction

All above are the in general parameters of performance affecting for micro milling machine table. But when studding in microns also have to consider following associated detail parameters in tabular format.

Table Geometry	**Vibration Isolation**	**Motion Type**
Weight	Type of Damper	Linear
Moment of Inertia	No. of Dampers	X- Axis
Size		Y-Axis
Shape		Z-Axis

Table 1.1

Source of Power	**Transmission System**	**Nature of Motion of Guide**
Individual Drive from its own motor	Mechanical	Drives for providing rotating movement
Group Drive from line shaft	Electrical	**a**.Rack and Pinion
	Pneumatic	**b**.Slider Crank
	Hydraulic	**c**.Screw and Nut
		d.Crank and rocker etc.
		e.Drives for producing rectilinear motion

Table 1.2

Bearing	**Hydraulic system**	**Electro-nic system**	**Electrical system**
Type	Tank Capacity	Sensor	Type of Motor
Backlash and Error	Oil Pressure	Transducers	Power Requirement
Max.Runout			
Material			

Table 1.3

By studing all above detail parameters will get remedies in the micromilling machine, can design the micro milling machine with new optimized design parameters.

FEM Analysis of Micro Milling Machine Slides:
With the help of FEM analysis will try to find out, the weakest section and most stressed part of the table.

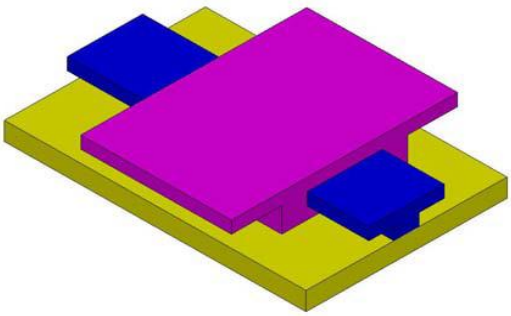

Fig.2.FEA model of slide.

FEM Analysis of Micro Milling Machine Bearing: With this the trouble related the micromilling machine bearing will be sort out.

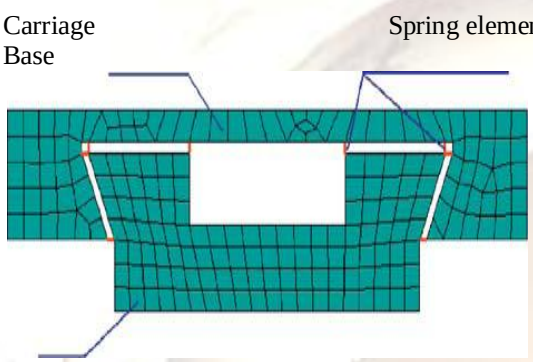

Fig.3. FEA Model of Air Bearing

FEM Analysis of Micro Milling Machine Drive Mechanism: with this the remedies and related problems in the drive of the micromilling machine will be find out.

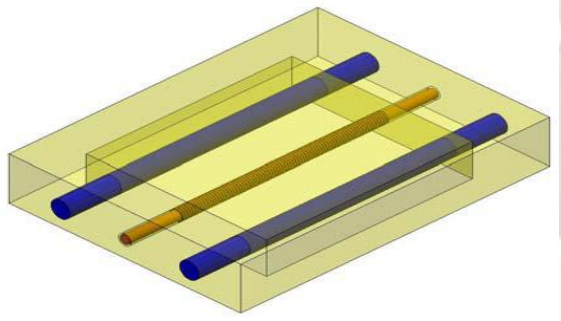

Fig.4.FEA Model of Recirculating Ball Screw

Conclusions:

Following outputs of this study are,

1. Affecting Parameters can be found out.
2. Slides problem can be eliminate by studying its FEM analysis
3. Bearing problem can be overcome by studying its FEM analysis
4. Drive mechanism can be improve by studying its FEM analysis.
5. Accuracy of table can be improve with this study.

With the help of all above outputs will helpful to design more precise and improved table for micromilling machine. It is also established the methodology for design and analysis of table for micromilling machine.

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