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Design of Inspection Fixture for Product with Slider Mechanism.

Swapnil Balpande¹, Abhilash R.Chopade², Viraj S. Shah³

B.E. Student, Department of Mechanical Engineering, Sinhgad College of Engineering, Vadgaon, Pune, India¹

B.E. Student, Department of Mechanical Engineering, Sinhgad College of Engineering, Vadgaon, Pune, India²

B.E. Student, Department of Mechanical Engineering, Sinhgad College of Engineering, Vadgaon, Pune, India³

ABSTRACT: Fixture is essential to maintaining the machining accuracy and to measure the tolerances. There are various types of fixture and these all different types depends on their specific applications. The fixture designing and manufacturing is considered to be very complicated process and requires knowledge of different areas such as geometry dimensions and tolerances procedure and manufacturing process. Fixture helps in reducing time for operation and eventually help productivity. Inspection being the utmost important process in manufacturing sector, it is executed at beginning when raw material is unloaded to after manufacturing of the product .The aim of the project is to design a fixture with slider mechanism to increase productivity.

KEYWORDS: Fixture, Inspection Fixture, Slider Mechanism.

I. INTRODUCTION

Fixture is a work holding device which hold the workpiece or raw material while manufacturing processes are been executed. There are various types of fixture for example assembly fixture, welding fixture, grinding fixture, inspection fixture. All these fixture are designed as per the specific applications and requirements. Designing a fixture is a complex process. There are various considerations which are kept in mind while designing a fixture. Some important considerations for designing of fixture are as follows.

- Dimensional Pre-analysis of component for which the fixture is to be designed.
- Main frame of the fixture should be firm enough to withstand the operation as well as weight of component.
- Component movement should be restricted.
- Clearance should be provided for loading and unloading of the component in the fixture.
- Clamping or Gauges arrangements should be feasible.
- Clamps and Gauges should not cause deformation to the work piece therefore proper material selections is crucial.

Many times small components are purchased from other dealers into the company and hence inspections of the components becomes the most important step, therefore inspection fixture is used. Inspection fixture is a type of fixture which helps in inspecting the components dimensions and to check if the component dimensions are within required dimensions or not. Inspection fixture are mostly used after a component is manufactured. To increase the productivity by decreasing the inspection time slider mechanism in mostly favoured. The slider mechanism enhances productivity by moving the component to the respective gauges to measure the tolerance once mounted.

Crucial component of the inspection fixture is the gauges. Gauge function is to verify the tolerance of the component. There are various types of gauges like snap gauge, dial gauge.

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II. DESIGN CALCULATIONS FOR SLIDER MECHANISM

For smooth function of the slider in X and Z directions. Designing of guide rod is the most important factor. As the guide rod had to withstand the weight of component as well as the component holder the material selection of the guide rod is on the basis of tensile strength, cost of the material, availability of material, manufacturability of material. The design of guide rods are based on bending failure. The formulae for bending stress is

$$\sigma = \frac{64My}{\pi d^4} \quad (1)$$

Where,

σ = Permissible stress N/mm².

M= Bending Moment Nmm

y = radial distance mm

d = Diameter of rod mm

Sut = Ultimate tensile strength of material.

1 Design of guide rod 1 and guide rod 2.

Guide rod 1 and 2 hold the product with the help of holder and translate the product with the holder in X direction. The material used for the guide rod 1 and 2 is 10C4 with young's modulus as 210000 MPa.

1.1 Assumptions for guide rod 1 and 2.

Factor of safety (Fs) = 2.5

Force on guide rod 1 & 2 = 150 N

Length = 86 mm

1.2 Permissible Stress (σ):-

$$\sigma = \frac{Sut}{F_s} \text{ N/mm}^2 \quad (2)$$

$$\sigma = \frac{350}{2.5} \text{ N/mm}^2$$

$$\sigma = 140 \text{ N/mm}^2$$

1.3 Diameter According to Bending Criteria:-

$$\sigma = \frac{64My}{\pi d^4}$$

$$d = \sqrt[3]{\frac{64Fl}{4\pi\sigma}}$$

$$d = 7.77 \text{ mm}$$

$$d = 8 \text{ mm}$$

2 Design of Guide Rod 3 and Guide Rod 4.

Guide rod 1 and 2 rests on the guide rod 3 and 4 for the movement in z direction with the Z slider. Therefore the force consideration for guide rod 3 and 4 is different than guide rod 1 and 2. Guide rod 3 and guide rod 4 translate the product in Z direction. Material used for guide rod 3 and 4 is 10C4 with young's modulus as 210000 MPa.

2.1 Assumptions for guide rod 3 and 4.

- Factor of safety = 2.5
- Force on guide rod 3 & 4 = 200 N
- Length = 230 mm

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2.2 Permissible Stress (σ):-

$$\sigma = \frac{S_{ut}}{F_s} \text{ N/mm}^2$$

$$\sigma = \frac{350}{2.5} \text{ N/mm}^2$$

$$\sigma = 140 \text{ N/mm}^2$$

2.3 Diameter According to Bending Criteria:-

$$\sigma = \frac{64My}{\pi d^4}$$

$$d = \sqrt[3]{\frac{64Fl}{4\pi\sigma}}$$

$$d = 11.8 \text{ mm}$$

$$d = 12 \text{ mm.}$$

III.MODELLING OF X,Z SLIDER AND VARIOUS PARTS

Modelling of X and Z sliders were carried out as per the requirement of the guide rods, the Product holder and assembly constraints of the inspection fixture. Parametric modelling was used in modelling of four snap gauges and various parts as per requirement. CAD model of important parts and assembly of the fixture are as follows:-

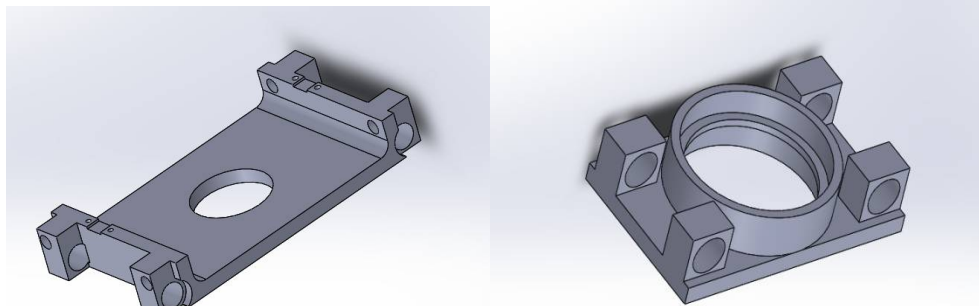


Figure 1 CAD Model of X (left) and Z (right) slider respectively

The above figures depict the X and Z slider which with the help of respective guide rods help in the movement of the product to the respective gauges within the fixture area. The Z slider is mounted on the X slider. The modelling of the X and Z slider is carried out as per requirement.

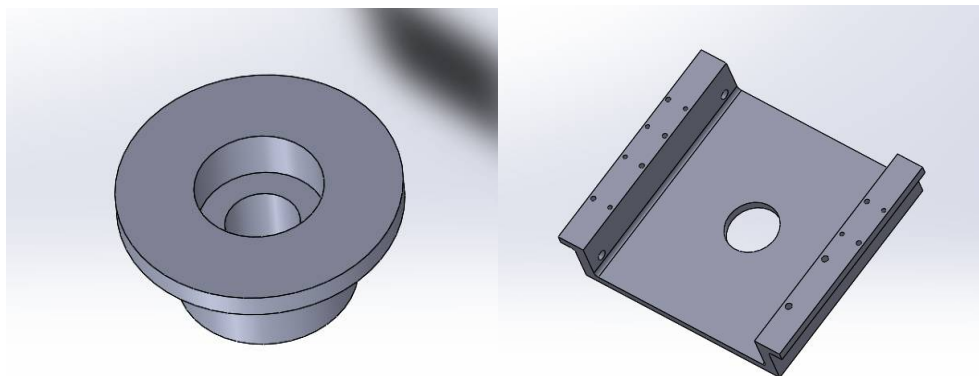


Figure 2 CAD Model of Part holder (left) and Base frame (right)

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The above figure shows the part holder and Base frame. Part holder is designed as per the product dimensions. Part holder is mounted on the Z slider and the product is inserted into the part holder. The base frame is designed as per the requirement and total weight consideration.

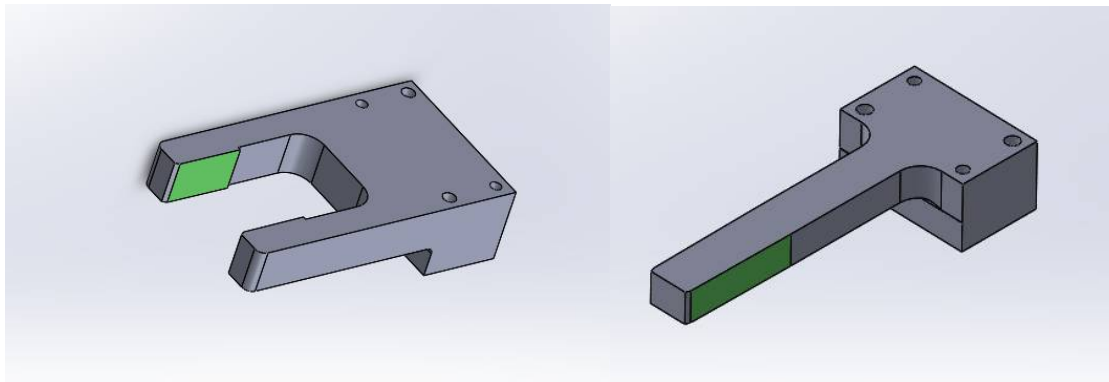


Figure 3 CAD Model of outer width (left) and slot gauge (right)

The above figure shows the Outer width and slot gauge. Outer width and slot gauge are designed as per the product dimensions. Outer width gauge verifies the outer width while slot gauge verifies the inner width. The outer width and slot gauges are snap gauge (Go/No Go gauge).

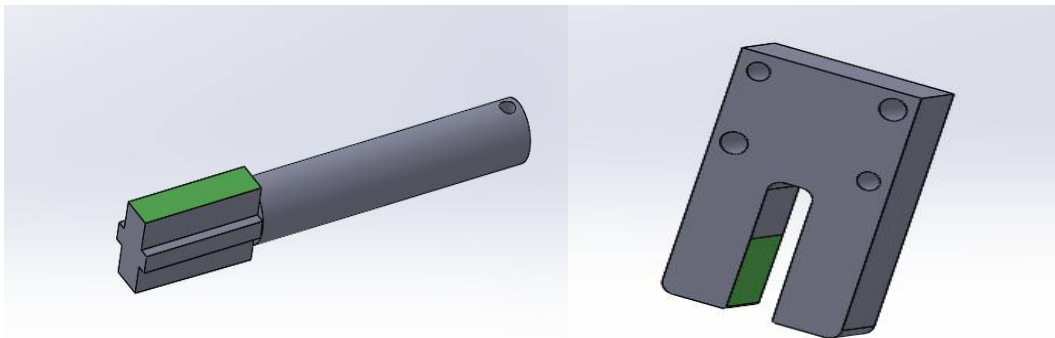


Figure 4 CAD Model of Perpendicular (left) and thickness gauge (right)

The above figure shows the perpendicular and thickness gauge. Perpendicular and thickness gauge are designed as per the product dimensions. Perpendicular gauge verifies the inner height while thickness gauge verifies the thickness. The perpendicular and thickness gauges are snap gauges (Go/No Go gauge).

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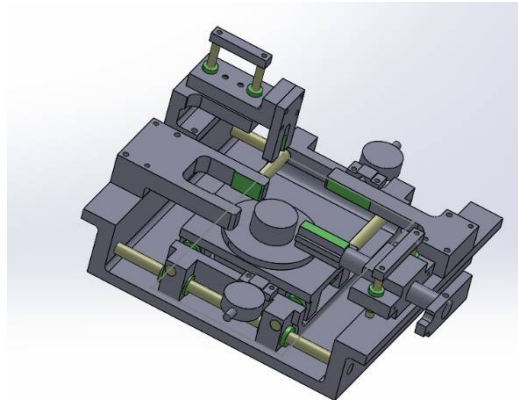


Figure 5 CAD Model of assembly of inspection fixture.

Figure 5 depicts the assembly of the inspection fixture with guide rods, X&Z sliders, four gauges and various other parts. The assembly is carried out only after the analysis of guide rods.

IV. ANALYSIS

It is necessary to carry out analysis of guide rods before the assembly to check whether the guide rods will sustain the load and force exerted on them. Since the guide rod is the critical element the analytical stress values are cross checked with the theoretical stress (permissible stress) values.

1 Analysis of Guide Rod 1 and Guide Rod 2.

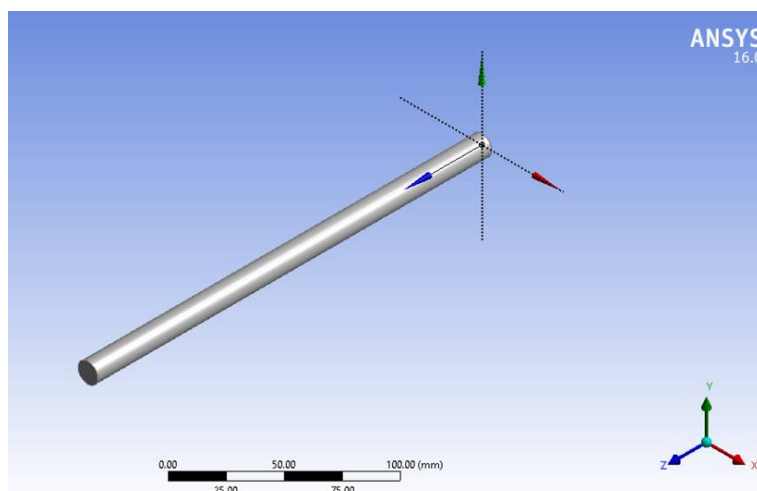


Figure 6 CAD Model of rod 1 and 2 in Ansys.

The above image is the design of guide rod 1 and 2. The guide rod 1 and 2 are of diameter 8 mm and length 86 mm. The CAD model of rod 1 and 2 is created in the Ansys.

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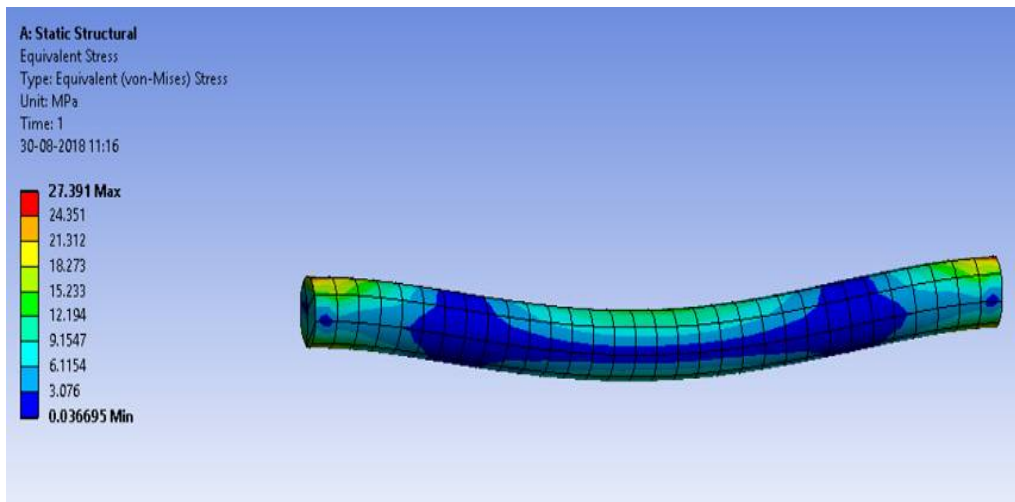


Figure 7 stress analysis of rod 1 and 2 in Ansys.

The stress analysis is carried out with load acting on the guide rod 1 and 2 is 150 N. Both ends of the rod are fixed. Young's Modulus is takes as 210000 MPa.

2Analysis of Guide Rod 3 and Guide Rod 4.

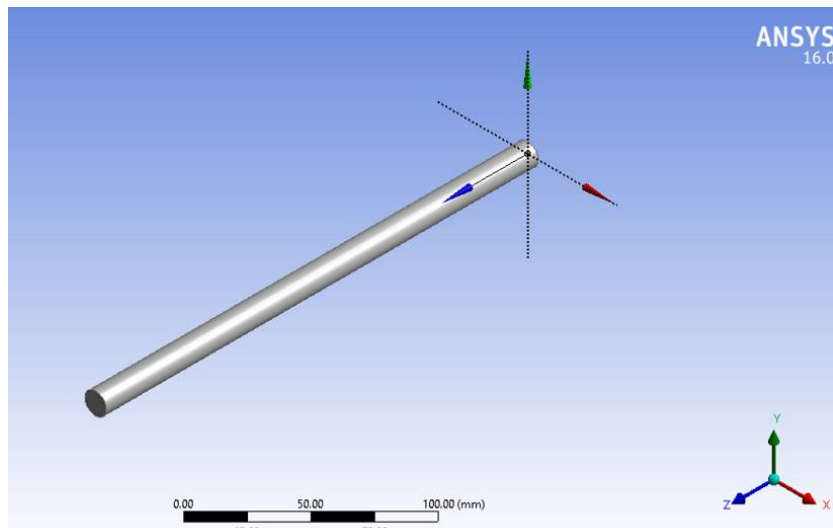


Figure 8 stress analysis of rod 1 and 2 in Ansys.

The above image is the design of guide rod 3 and 4. The guide rod 3 and 4 are of diameter 12 mm and length 230 mm. The CAD model of rod 3 and 4 is created in the Ansys.

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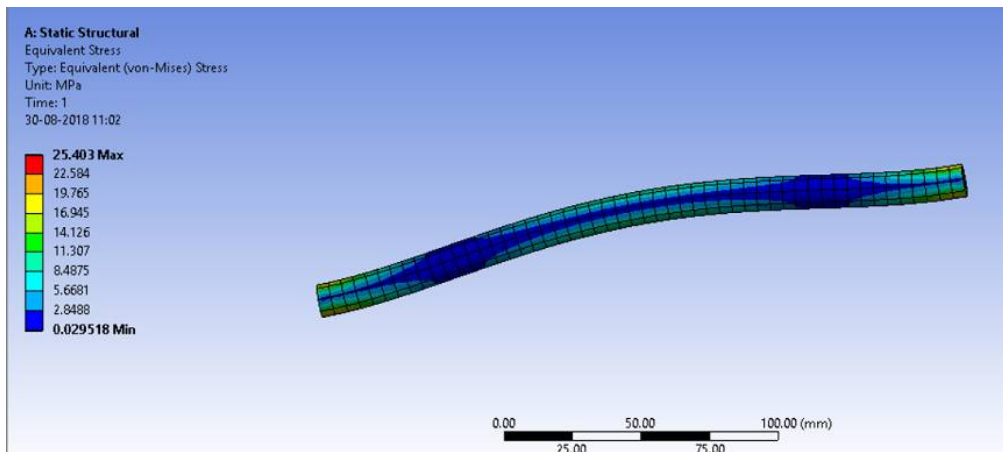


Figure 9 stress analysis of rod 1 and 2 in Ansys.

The stress analysis is carried out with load acting on the guide rod 3 and 4 is 200 N. Both ends of the rod are fixed. Young's Modulus is taken as 210000 MPa.

As it can be seen from the figures that the maximum stress by analysis is 27.39 N/mm² for guide rod 1 and guide rod 2 which is less than the permissible stress of 140 N/mm² while for guide rod 3 and guide rod 4 25.40 N/mm² is the maximum stress by analysis which is less than the limit of 140 N/mm² by theoretical calculation. Therefore the design for the guide rod 1, guide rod 2, guide rod 3, and guide rod 4 are safe.

V. CONCLUSION

The following comments could be concluded:

1. The designed guide rods with Sliders can be introduced into the inspection fixture which can lead to reduction in inspection time and hence increase the productivity.
2. The analytical value of stress for guide rod 1 and rod 2 is 27.391 N/mm² which are less than permissible value of 140 N/mm² therefore the guide rod 1 and 2 are safe.
3. The analytical value of stress for guide rod 3 and rod 4 is 24.403 N/mm² which are less than permissible value of 140 N/mm² therefore the guide rod 3 and 4 are safe.

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