# Performance Analysis of Thread Inspection Machine

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*Abstract*— Our study aims to perform analysis of thread inspection machine. It involves the design and development of thread checking machine. The main reason for selecting project is to reduce the errors and automate the thread inspection process the errors they are accommodating at present. As we know that thread inspection is the essential process for the company. They inspect the type of thread in the product i.e. it will be M6 or M8. So they have to check that all the threads are either M6 or M8. Currently they use metal rod to check the type of thread manually, checking the thread by inserting the rod on each hole is time consuming process. It lags the production process. So the company needs to design a thread inspection machine. The objective of the project to automate the thread inspection process, generate the CAD model of semi-automated thread inspection machine using solid works, perform the design and analysis of semi-automated thread inspection machine using FEA, design a machine for increasing productivity and minimize process time, to increase the product quality and reduce labour cost. On the basis of objective, the CAD model of Thread inspection machine was design using Solidworks. After CAD modelling the Finite Element Modelling and Finite Element Analysis was carried out by using HYPERMESH and Nastran to validate the Designed CAD model. The linear static analysis results shows that the stresses are well within the safe limit, hence the design is safe.

***Key words:*** Thread Inspection Machine, FEA, CAD Model

## I. INTRODUCTION

Inspection is the most common method of attaining standardisation, uniformity and quality of workmanship. By “inspection” it is usually meant that, at certain stages in the course of production, a comparison is made between what has actually been produced and what should have been produced. The standard of reference may be a specification, drawing or a visual quality standard.

In present scenario, manual inspection is largely replaced by automated inspection as errors are reduced to great extent by automation of the process. Economic justification of an automated inspection system depends on whether the savings in labour cost and improvement in accuracy will be more than the investment and/or development costs of the system.

### *A. Automated inspection*

Automated inspection is defined as the automation of one or more steps involved in the inspection procedure. Automated or semi-automated inspection can be implemented in the number of alternative ways.

### *B. Inspection of production process*

The work of inspection is done while the production process is simultaneously going on. Inspection is done at various work centres of men and machines and at the critical production points. This had the advantage of preventing wastage of time and money on defective units and preventing delays in assembly.

### *C. On-line/In-process and On-line/Post-process Inspection Methods*

If the task of inspection is done as the parts are manufactured, then it is called as online inspection. There are two variations of on-line inspection. If the inspection is performed during the manufacturing operation, it is called on-line/in-process inspection. If the inspection is performed immediately following the production process, it is called on-line/post-process inspection.

The classical examples of online inspection are inspection probes. These probes can be used in a large variety of ways. For example, they can be mounted in holders, inserted into machine-tool spindles, or stored in a tool magazine to be exchanged by an automatic tool exchanger just as tools are handled. In flexible manufacturing system machine tools spindle mounted probes are commonly used. The primary inspection elements of the probes are sensors. Signals are transmitted to the controller as the contact is made with the part surface. Numerous technologies are available for transmitting the signals. Some of them are direct electrical connection, induction coil, infrared data transmission. The task of the data processing and interpretation is facilitated through the controller.

Fig. : Inspection Probes

### *D. Automation Principles and Strategies*

There are certain fundamental principles and strategies that can be employed to improve productivity in manufacturing operations. The USA Principle is a common sense approach to automation projects. Similar procedures have been suggested in the manufacturing and automation trade literature, but none has a more captivating title than this one. USA stands for;

1) Understand the existing process
2) Simplify the process
3) Automate the process.

## II. DATA ACCUMULATION

### *A. Existing process*

The traditional method of thread detection are such as pass/check gauge calibration method, three stitches, micrometer method, etc. Among the various thread parameters, the pitch diameter is the most commonly used criterion for thread measurement. Thread inspection is the essential process for the company. In the existing process they inspect the type of thread in the product i.e. it will be M6 or M8. So they have to check that all the threads is either M6 or M8. Currently a metal rod of standard size is passed through every hole manually by worker to check the type of thread. Inserting the rod manually in every hole is time consuming process which lags the production process.

Each product has 8 holes with threads, 1 worker finishes one product in 5 minutes approx.

Work of 1 person in 1 hour = 60 / 5 = 12 products = 12 x 8 = 96 holes

Work of 1 person in 1 day (8 hours working) = 12 x 8 = 96 products = 96 x 8 = 768 holes

2-3 persons work in 1 day

3 persons x 96 products = 288 products = 288 x 8 = 2304 holes/day

## III. Design Calculations

### A. *Process Working*

1) At first product should placed at between side supports
2) Top plate should be constraint properly to restrict vertical movement of product
3) 30 N Pneumatic force apply at fixture through the base actuator
4) By the application of force measuring rods pass through the holes

### B. *Force calculation*

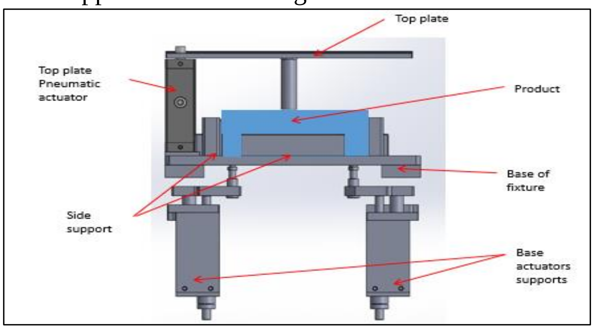
There are 2 fixture each has to operate 4 measuring bars.

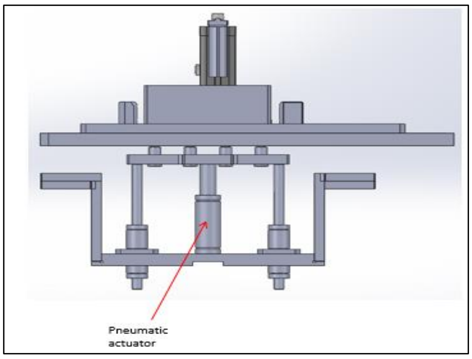
Force required to lift a single fixture

Mass of single fixture = 1.5 Kg max.

Total force required to lift = 1.5 x 9.81 = 14.715 N

From the force calculations, 15 N Pneumatic force required to operate the 1 fixture, Hence 3 Pneumatic actuator required. 2 for measuring bar fixtures and 1 for product vertical support as shown in figure




## IV. CAD Modeling

Cad Model of the Thread inspection machine as per the design calculations:

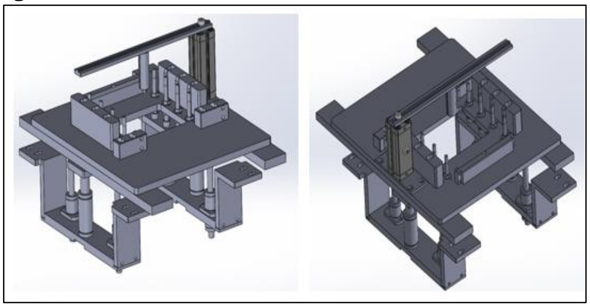


Fig. : Isometric View of thread inspection machine

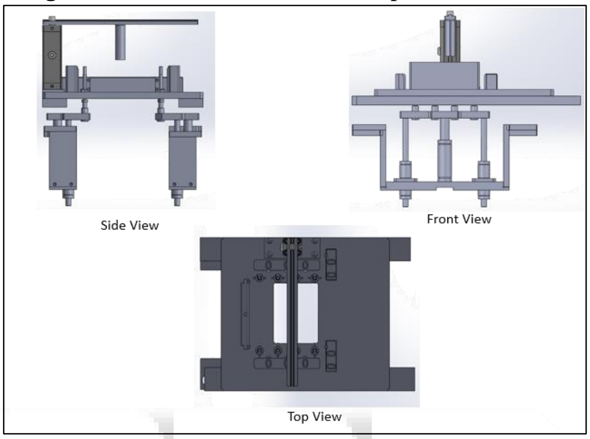



Fig. : Different views of CAD model

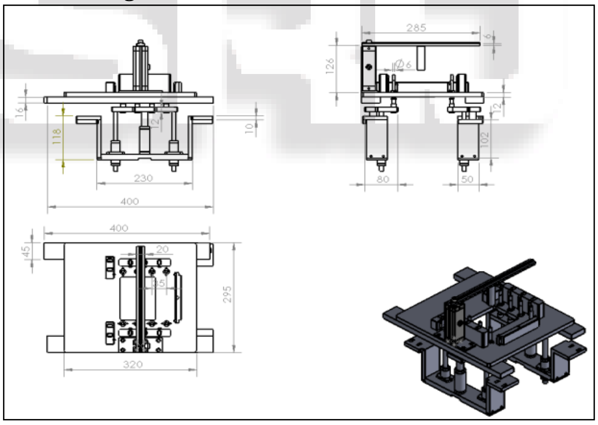


Fig. : Detailing of thread inspection machine

## V. Finite Element Analysis

### A. *Displacement*

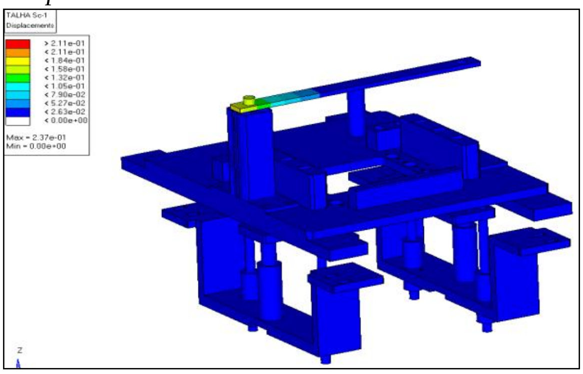


Fig. : Maximum Displacement = 0.237 mm

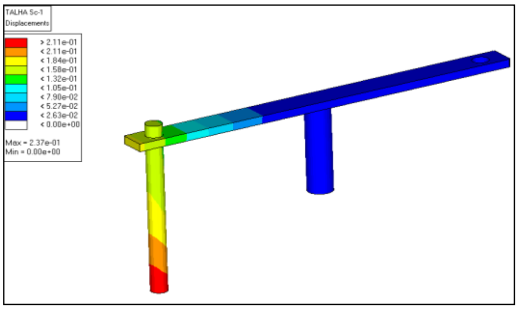


Fig: Maximum Displacement = 0.237 mm

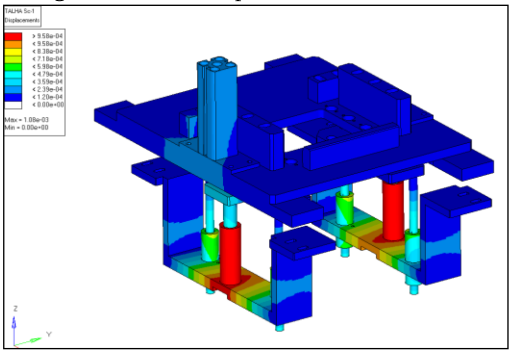


Fig: Maximum Displacement = 0.001 mm

### *B. STRESSES*

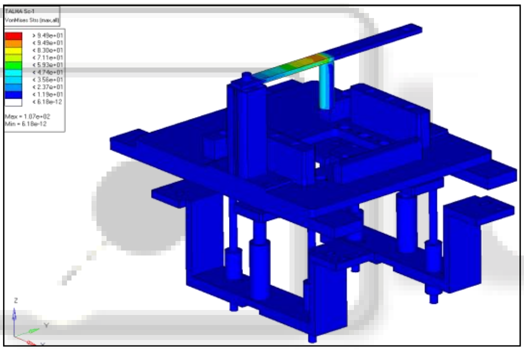


Fig. : Maximum stress = 107 MPa

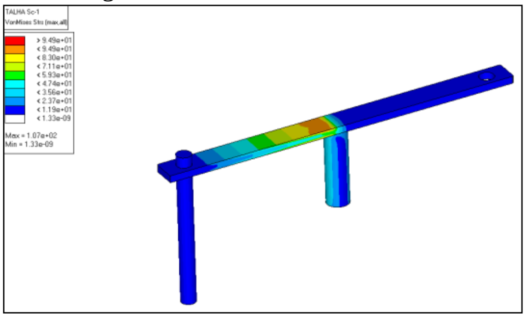


Fig: Maximum stress = 107 MPa

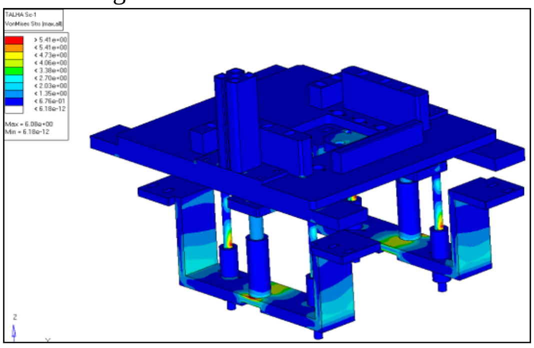


Fig: Maximum stress = 6 MPa

## VI. RESULT DISCUSSION

Maximum pneumatic force of 15N is applied on each piston and cylinder. To check the effects of maximum forces on the designed structure a Linear static Analysis is carried out by using Finite Element Analysis Technique.

From the Results of Finite Element Analysis it is observed that maximum displacement of 0.237 mm and maximum stress 107 MPa developed in upper piston as it is the most critical part in the assembly. While in other parts average displacement is 0.001 mm and stress is 6 MPa.

As the maximum developed stresses 107 MPa are well within the yield stress of assembly material, Hence design is safe for the given loading conditions.

| Physical Properties | Metric | English | Comments |
|---|---|---|---|
| Density | 2.78 g/cc | 0.1 lb/in³ | AA; Typical |
| **Mechanical Properties** | | | |
| Hardness, Brinell | 120 | 120 | AA; Typical; 500 g load; 10 mm ball |
| Hardness, Knoop | 150 | 150 | Converted from Brinell Hardness Value |
| Hardness, Rockwell A | 46.8 | 46.8 | Converted from Brinell Hardness Value |
| Hardness, Rockwell B | 75 | 75 | Converted from Brinell Hardness Value |
| Hardness, Vickers | 137 | 137 | Converted from Brinell Hardness Value |
| Ultimate Tensile Strength | 469 MPa | 68000 psi | AA; Typical |
| Tensile Yield Strength | 324 MPa | 47000 psi | AA; Typical |
| Elongation at Break | 19 % | 19 % | AA; Typical; 1/2 in. (12.7 mm) Diameter |
| Elongation at Break | 20 % | 20 % | AA; Typical; 1/16 in. (1.6 mm) Thickness |
| Modulus of Elasticity | 73.1 GPa | 10600 ksi | AA; Typical; Average of tension and compression. Compression modulus is about 2% greater than tensile modulus. |
| Ultimate Bearing Strength | 814 MPa | 118000 psi | Edge distance/pin diameter = 2.0 |
| Bearing Yield Strength | 441 MPa | 64000 psi | Edge distance/pin diameter = 2.0 |
| Poisson's Ratio | 0.33 | 0.33 | |

Fig. : Material properties of aluminium

## VII. CONCLUSION

As per the requirement Thread inspection machine is designed with collected detail data. This project is to reduce the errors and automate the thread inspection process the errors they are accommodating at present. As we know that thread inspection is the essential process for the company. They inspect the type of thread in the product. Currently they use metal rod to check the type of thread manually, checking the thread by inserting the rod on each hole is time consuming process. It lags the production process. So the company designed a thread inspection machine.

On the basis of objective, data accumulated and design calculations a cad model of threading inspection machine is modeled using Solidworks.

After CAD modelling the Finite Element Modelling and Finite Element Analysis was carried out by using HYPERMESH and Nastran to validate the Designed CAD model. The linear static analysis results shows that the stresses are well within the safe limit, hence the design is safe. The product quality has been improved. This machine will also help to reduce the wastage of material, which plays an important role in product cost.

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