STUDY ON STRUCTURE PERFORMANCE OF INHOUSE NON-DESTRUCTIVE UNIT SYSTEM

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STUDY ON STRUCTURE PERFORMANCE OF INHOUSE NON-DESTRUCTIVE UNIT SYSTEM

by

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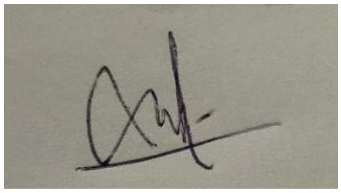
ENDORSEMENT

I, Muhammad Ashraff Bin Husny hereby declare that all corrections made by the supervisor and examiner have been taken consideration and rectified accordingly.



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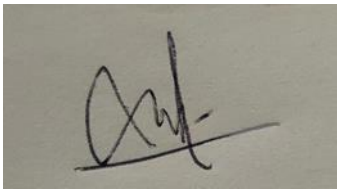
DECLARATION

This thesis is the result of my own investigation, except where otherwise stated and has not previously been accepted in substance for any degree and is not being concurrently submitted in candidature for any other degree.



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STUDY ON STRUCTURE PERFORMANCE OF INHOUSE NON-DESTRUCTIVE UNIT SYSTEM

ABSTRACT

This research is to study the structure performance of NDT machine prototypes available in the lab. When the NDT machine prototype is running, it produces vibration to the rotation of the motor.

This study is to determine the reliability of the structure of the NDT machine prototype as it may affect the reading of the measurement due to the interference of vibration coming from the motor. Initially, a vibration analysis will be done in the lab but due to the COVID-19 lockdown, the analysis will be done using ANSYS software.

The findings also show the necessity for adjustments of the parameters of the NDT machine prototype in the future based on the results from this study.

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LIST OF ABBREVIATIONS

NDT- Non-destructive testing

LIST OF SYMBOLS

MPa

CHAPTER 1

INTRODUCTION

1.1 Research background

The properties and characteristics of materials had always been a fundamental aspect in all types on industry. The aerospace industry put emphasize on material quality in the highest degree due to strict regulations and high safety requirements for all aircraft manufactured. Material properties are subjected to change when applied with external force, so conventional processes of measuring are not suitable as it may damage the material. The purpose of this research is to develop a method and gather technical data on homogenous and non-homogenous materials through non-destructive evaluation using a non – contact measurement device.

Non – contact measurement is a key player in the manufacturing industry and engineering work. Many traditional contact measurement devices such as micrometres and vernier callipers touch the surface of the material being measured which causes several disadvantages. Firstly, if a part is not fixed or placed in a static position, the area between the touching point of the instrument and the surface of the material is likely to relay an inconsistent measurement result. This leads to measurements being not accurate and unreliable. Since traditional measuring devices require touching the surface of the material to obtain the measurement, it may leave a mark or damage the material.

On the contrary, non – contact measurement device lacks the disadvantages of traditional measuring devices. Non – contact measurement device produces immediate results thus reducing time as there is no need for human interpretation. The data gathered from the measurements can be uploaded quickly for analysis as non – contact measurement devices can be connected to a computer. The procedure of measuring using a non - contact measurement device can be repeated for increased accuracy and reliability of the measurements obtained.

1.2 Problem statement

Non – contact measurement devices come in various configurations and usage. Some of them are designed for a specific task using a specific type of material. Therefore, the accuracy and reliability of these devices are not standardized.

Since the experiment is using a prototype scale machine, the accuracy of the reading of the measurements is considered as factor that will influence the results from the homogenous and non - homogenous material.

1.3 Research objective

The objectives of this research are:

i. To conduct analysis on various prototypes of NDT machine prototypes in the lab
ii. Gather and analyse the data from the analysis using the NDT machine prototype and compare between the various configuration

1.4 Thesis outline

In this thesis, there are a total of five chapters which includes introduction, literature review, methodology, results and discussions and conclusions with recommendations. In Chapter 1, the introduction briefly explained the aim of this research in the form of the research background. It is also supported by the problem statement explained in this chapter and the research objectives is shown clearly.

Chapter 2 mainly explain the critical reviews based on the literature study related to this research. In this chapter, findings on non – contact measurement device, homogenous and non – homogenous material were presented based on past research journals. The findings assist in developing the idea and the understanding upon completing the research .

In Chapter 3, the method and technique used throughout the project development were explained.

Next, in Chapter 4 the results obtained were explained and discussed.

Finally, Chapter 5 includes the conclusion of this research and some future recommendations for future study or development.

CHAPTER 2

LITERATURE REVIEW

2.1 Non destructive testing

2.1.1 Introduction

NDT can be used to check the quality of the material from the stages of raw material, fabrication, and in-service inspection. NDT is used to make sure that the material has the capacity to assure that they do not fail within the calculated time. Non– destructive evaluation has many terms to describe the activities within the field. Non-destructive testing refers to the process of inspecting and determining if a material has defects or irregularities. NDT techniques are commonly used to identify and minimize defect-prone materials. Various types of flaws can be detected using NDT techniques. These flaws can be identified by looking for various types of defects.

2.1.2 Visual Inspection

Visual testing is a technique utilized for inspecting various materials. This procedure involves using the aid of an observer to spot potential issues in a material (Deepak et al., 2021). This process involves use of various optical aids such as mirrors, magnifier glasses, etc.

2.1.3 Ultrasonic testing

The ultrasonic testing is used to check the internal defects of welded materials. The principle of the test is that a small amount of sound produced by a transducer is enough to vibrate a crystal called piezoelectric which will vibrate for a less period at a frequency that is equal to the thickness of the crystal (Deepak et al., 2021). The ultrasonic trace is used to identify the discontinuities in welded materials such as steel. It can be used in various industries such as pressure vessels and railroad wheels.

2.1.4 Radiography

Radiography uses x-rays to examine a specimen. The x-rays penetrate through the material and record the data**.** The base is made of polyester and the film has a transparent medium. The film is protected by a layer of protective coating to safeguard the film externally . Large radiation is passed in defecting areas and the film appears to be darker. After that, the film is processed for any possibilities of defects and varying density (Deepak et al., 2021). The x-ray radiation has a sensitivity of 2-4% of material thickness. Gamma rays are more sensitive and can penetrate a specimen without damaging it.

Techniques	**Capabilities**	**Disadvantages**
Visual inspection	Large visible surface	Small defects are difficult to detect
Ultrasonic testing	Can be used on internal and external surfaces	Testing material must be able to conduct sound
Radiography	Used for finding internal defects	Unsuitable for porous materials

Table 2.1. *Capabilities of various NDT method.*

CHAPTER 3

METHODOLOGY

3.1 Non-destructive testing machine prototypes

3.1.1 Welded joint NDT machine prototype

The first prototype used for this project is a welded joint NDT machine prototype. The material is made from structural steel.

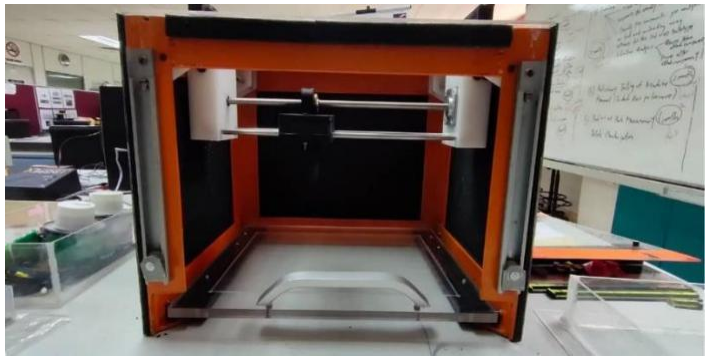

Figure 3.1 *Welded joint NDT machine prototype front view*

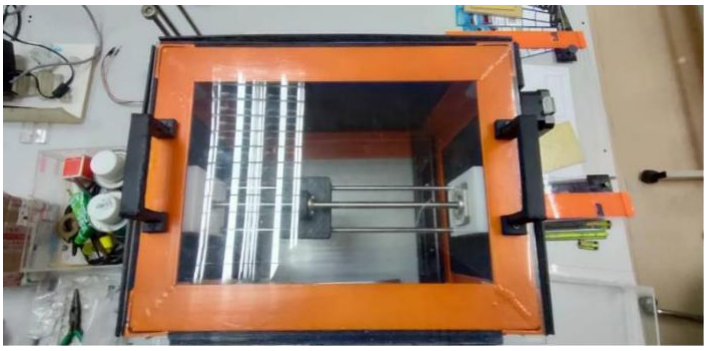

Figure 3.2 *Welded joint NDT machine front view*

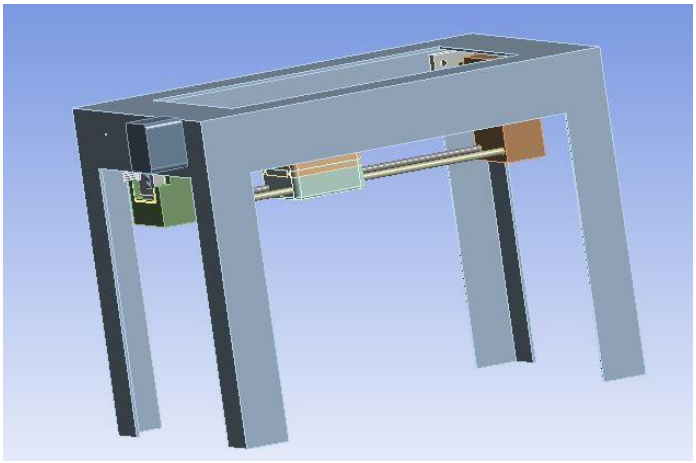

Figure 3.3 *Welded joint NDT machine model*

3.1.2 Rivet joint NDT machine prototype

The second prototype used for this project is a screw joint NDT machine prototype. The material is made from aluminum.

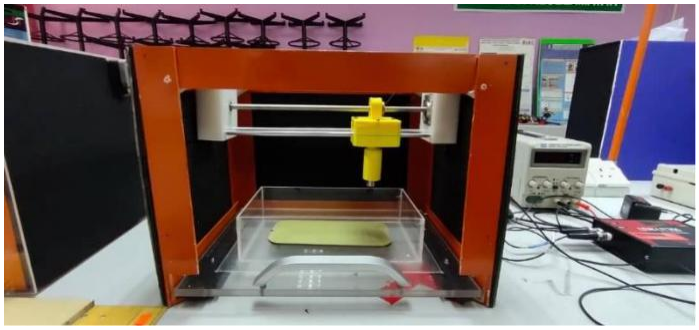

Figure 3.4 *Rivet joint NDT machine prototype front view*

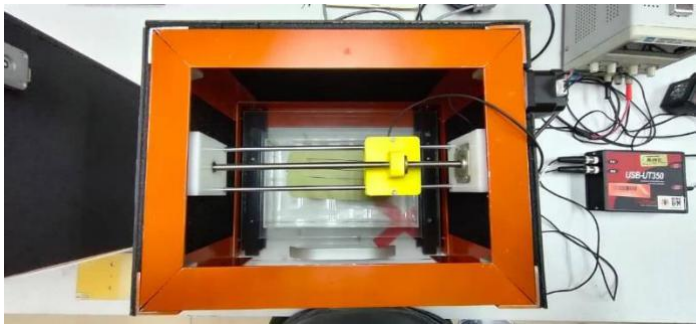

Figure 3.5 *Rivet joint NDT machine prototype top view*

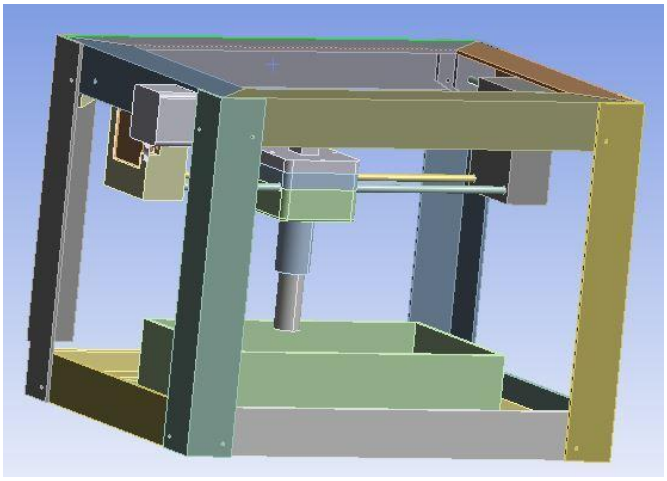

Figure 3.6 *Rivet joint NDT machine model*

3.2 Structure analysis

3.2.1 ANSYS Workbench

Both NDT machine prototype is analysed using this software to show the stress exerted on both NDT machine prototypes during vibration.

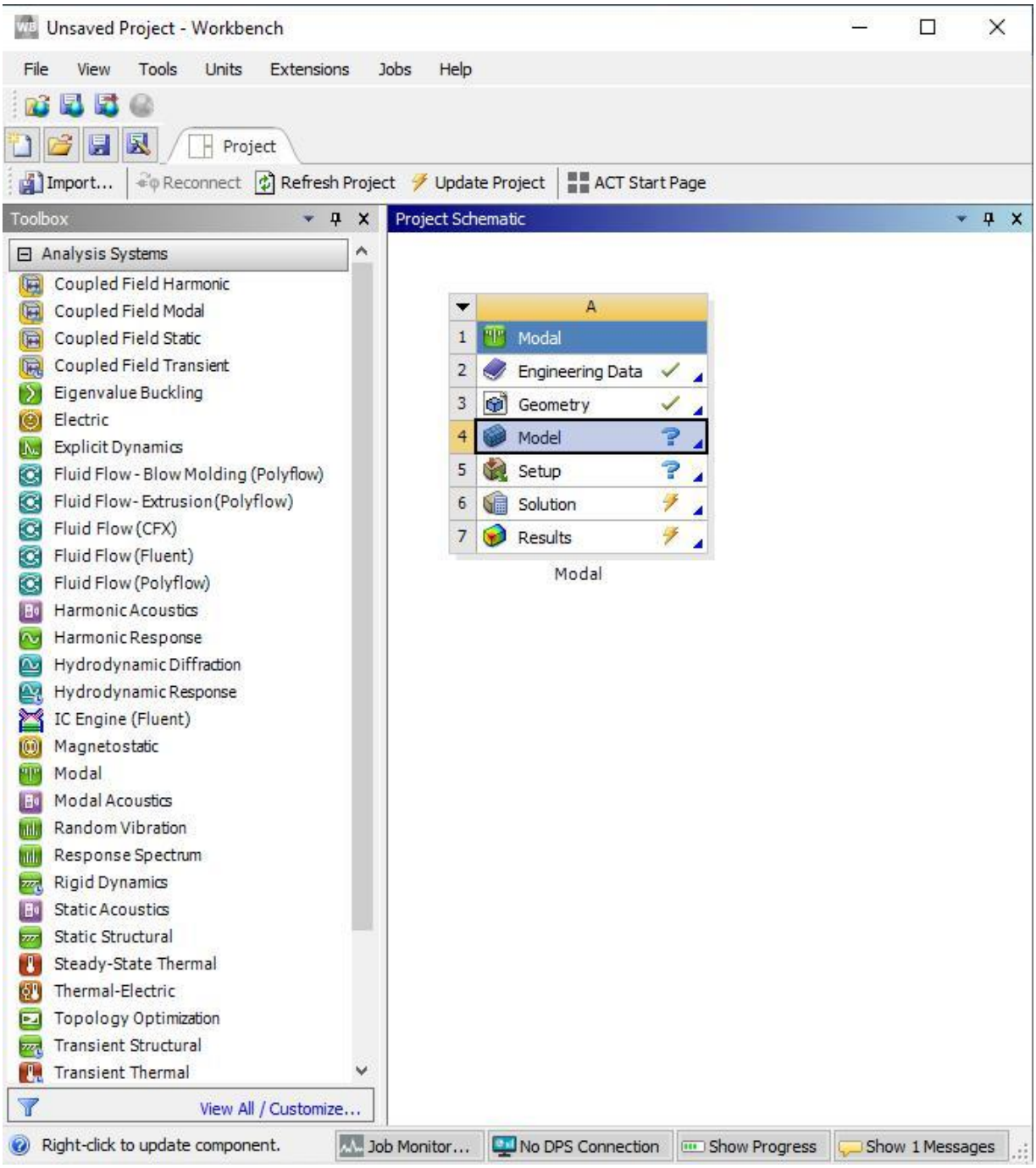

Figure 3.7 *Ansys Workbench interface*

The .IGS file of both NDT machine prototype is imported into the software and run under modal analysis.

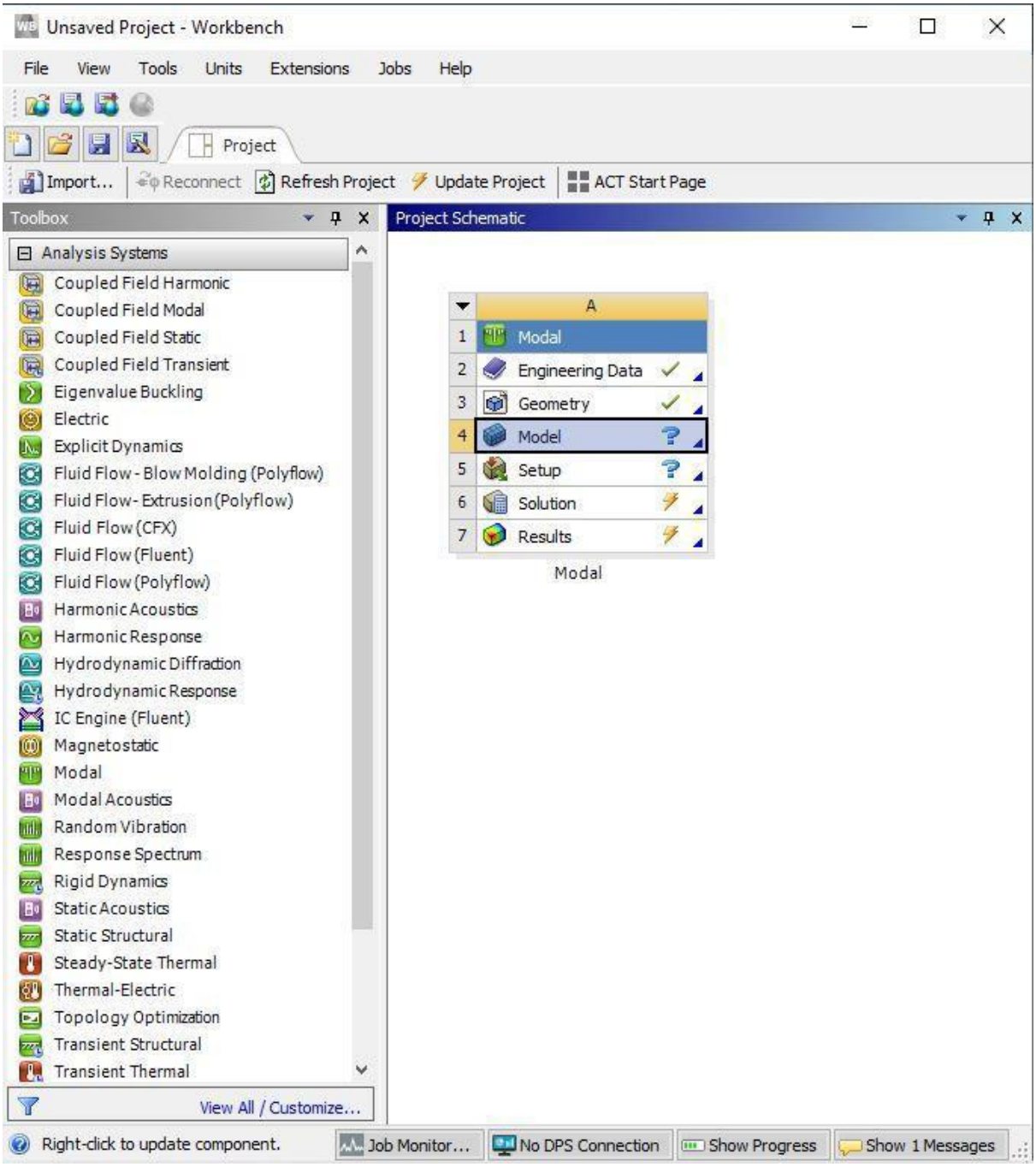

Figure 3.8 *Modal analysis interface*

After the modal analysis is done, random vibration analysis is done.

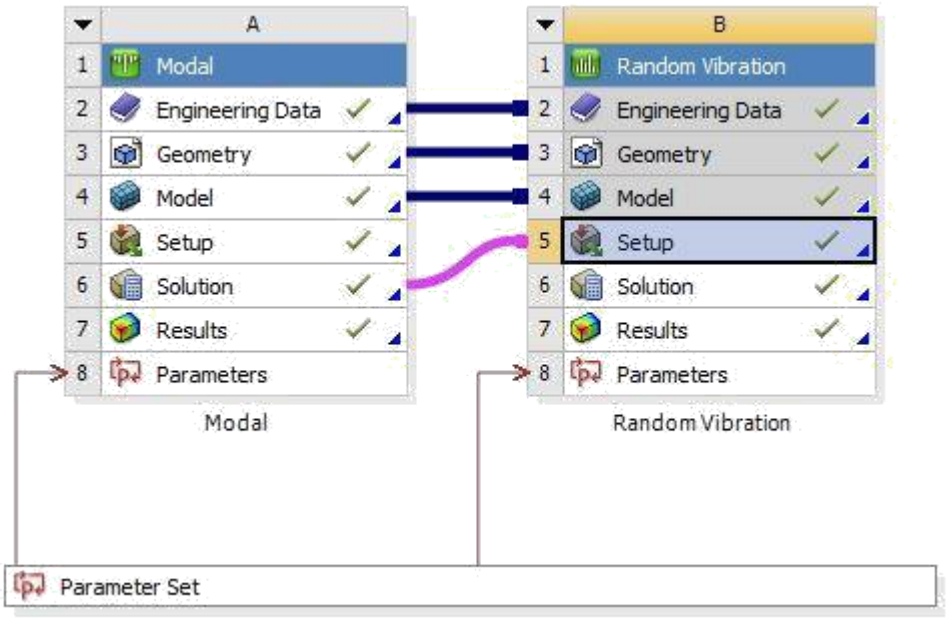

Figure 3.9 *Random vibration analysis interface*

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Welded joint NDT machine prototype

4.1.1 Modal analysis

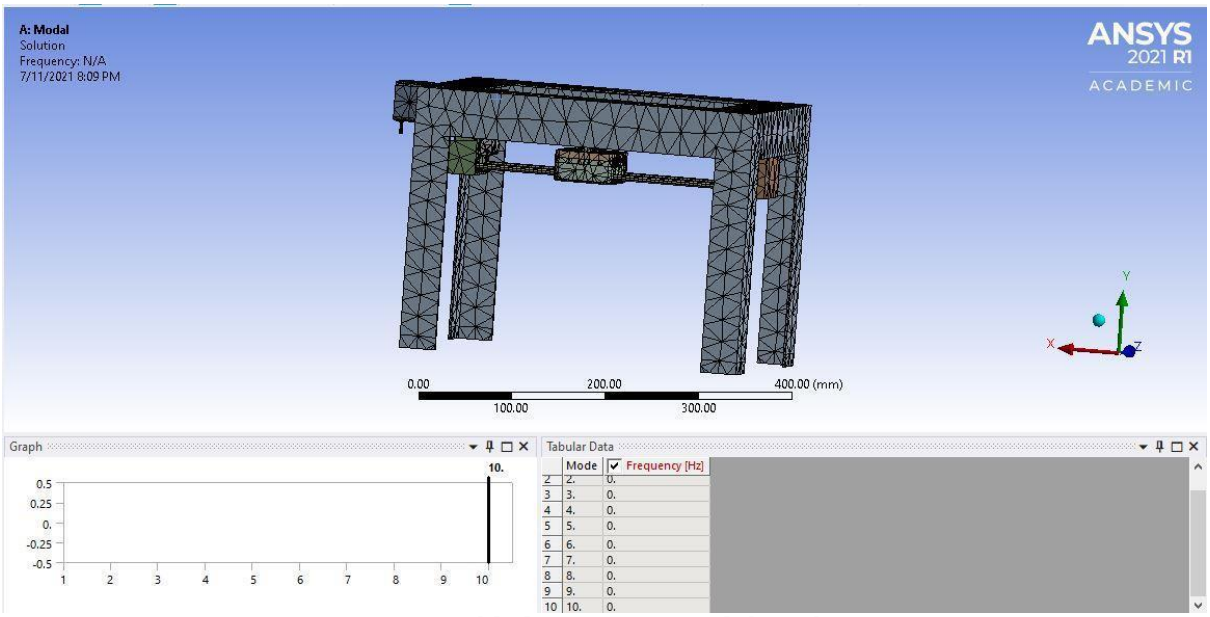

Figure 4.1 *Welded joint NDT modal analysis*

The model is analysed using pre-stress modal analysis. The analysis is run through 10 modes.

No.	Mode	Frequency (Hz)
1	1	1
2	2	2
3	3	3
4	4	4
5	5	5
6	6	6
7	7	7
8	8	8
9	9	9
10	10	10

Table 4.1 *Welded NDT modal analysis*

4.1.2 Random vibration analysis

After modal analysis is done, the model is analysed using random vibration analysis using these parameters.

No	Frequency (Hz)	Acceleration $(mm/s^2)^2/Hz$
1	0.5	2
2	1	4
3	1.5	6
4	2	8
5	2.5	10

Table 4.2 *Welded NDT random vibration analysis*

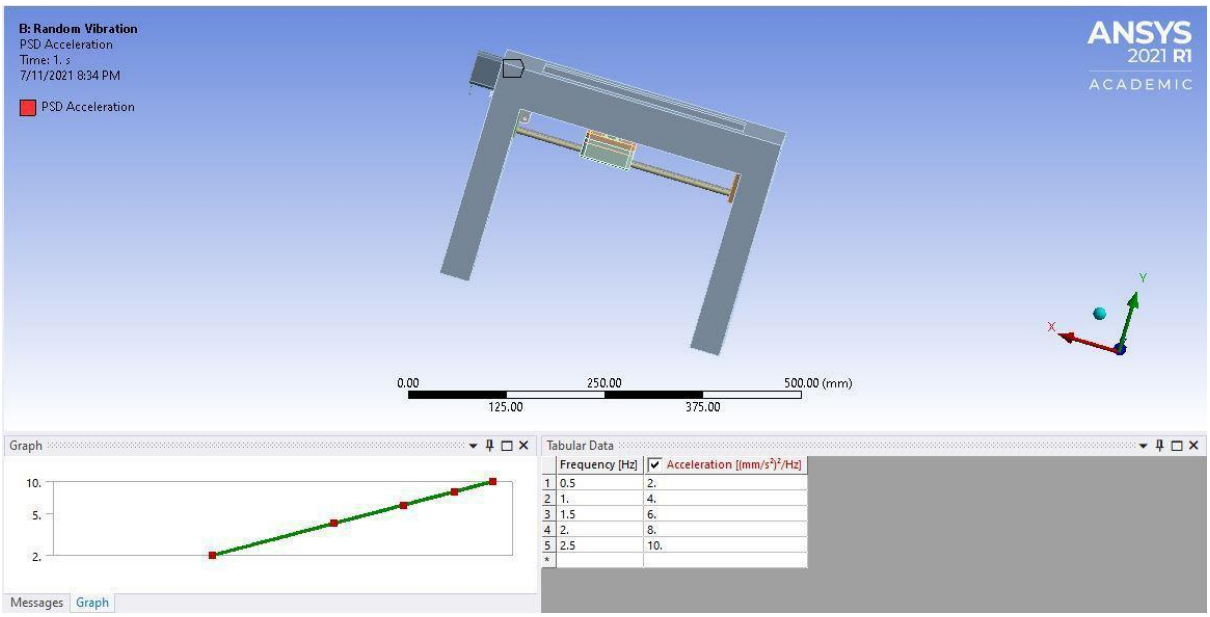

Figure 4.2 *Welded joint NDT random vibration analysis*

4.1.3 Directional deformation

After both analysis is done, the results are transferred in the form of directional deformation of an axis and the Von Mises stress.

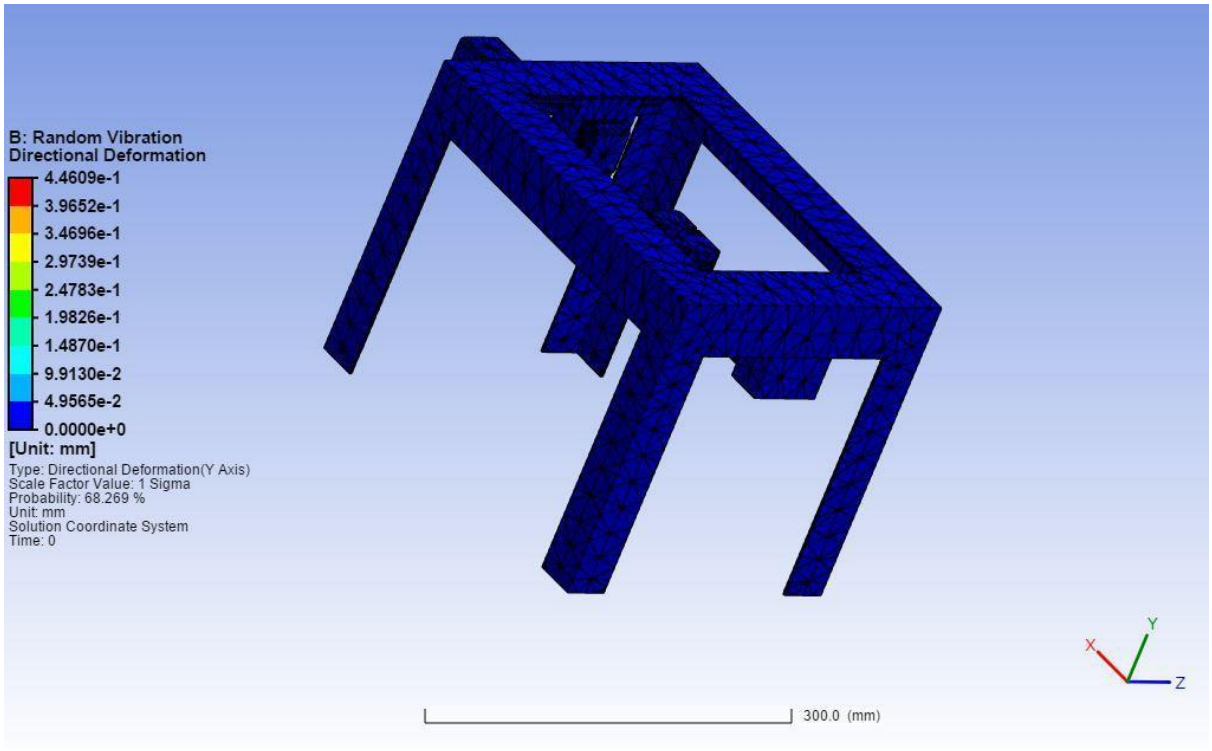

Figure 4.3 *Welded joint NDT directional deformation*

The model of the structure shows that it does not undergo any deformation as its is made from structural steel and the frequency of vibration applied to the structure is small.

4.1.4 Von Mises stress

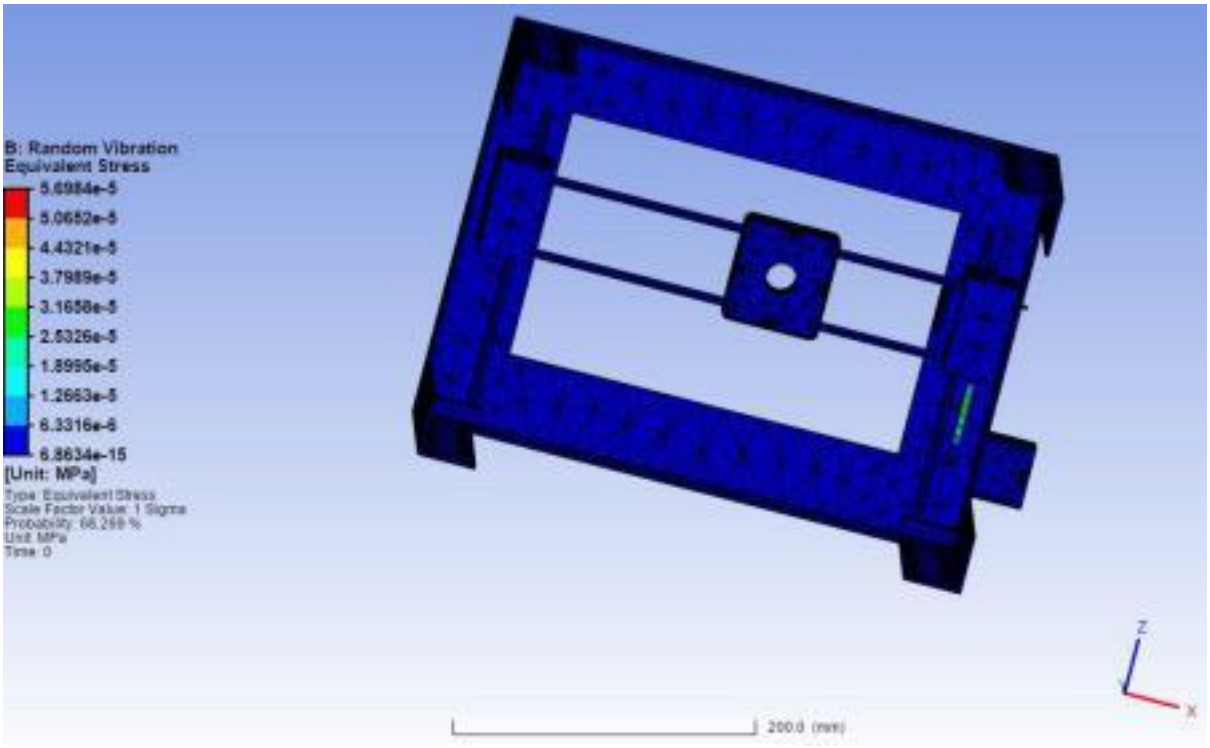

Figure 4.4 *Welded joint NDT Von Mises stress*

As seen in the diagram above, the only noticeable form the is stress is exerted on belting which moves the holder in the direction of pressure Z-axis. The highest is 5.698×10^{-5} MPa while the lowest pressure is 6.863×10^{-15} MPa.

CHAPTER 5

CONLCUSIONS AND RECOMMNEDATIONS

5.1 Conclusions

In this research, the structural performance of inhouse NDT machine is analysed to determine its accuracy and reliability when conducting tests on various specimens.

Since the NDT machine undergoes vibration when running a procedure, modal analysis and random vibration analysis is done to simulate the results. From the findings of both analyses, it is shown that the vibration only impacts minimally on the structure because of the strength of the material and the position of the motor.

5.2 Recommendations

In the future, the experiment could be done in lab to obtain better results regarding the simulation when the NDT machine is running.

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