

# 1 INTRODUCTION

## 1.1 Background

Nowadays, force reconstruction has become an interesting research topic in machine and structural dynamic fields. This condition occurs because a direct measurement of the excitation force is very difficult to be conducted. A simple method to predict the excitation force is by using the reconstruction algorithm which is derived using system response data [1].

In this research, application of force reconstruction technique is used to predict the excitation force which acting on two degrees of freedom shear structure. Force prediction is one of interesting inverse problems and important for engineering design and application [2]. The knowledge of the input force on structures is beneficial to the design and operation of the system [3]. When the structure is subjected to an unknown force, the knowledge of mathematical model to represent the structure and the measured response due to the unknown force is essential so as to develop the force prediction model for determining the force contents [3]. Verhoeven [4] used measured operational vibration data to calculate the total excitation forces of the rotating machine by an analytical modal analysis approach. Busby and Trujillo [5] performed TMA (Theoretical Modal Analysis) to obtain system modal parameters and so forth to estimate the system response in order to find the unknown force time history.

Force reconstruction is an inverse method of dynamic response [6]. This method emerges because of the difficulties of measuring forces which appear on structure which impossible to be measured [6]. Most of this case was found in aerospace engineering in example is determining interface force on satellite structure.

In this experimental study, the excitation force is applied to the base of the structure [7] and the system response is measured at the each mass of the structure. This is the simplest and fastest of the various techniques commonly used today [8]. An algorithm of force reconstruction is developed for this force reconstruction. The research regard to regression analysis which is expected can minimize the error result between simulation and experiment.

This research is already developed by Bur, M at all [6] and has also developed into the newest research. But in order to make a further research which regard to force reconstruction in Mechanical Engineering Department of Andalas University, our department need a basic experimental study as the first step to conduct a development research in force reconstruction study. And this research is the stepping stone of force reconstruction technique at Structural Dynamic Laboratory of Mechanical Engineering Department of Andalas University.

This research consists of experimental study and algorithm simulation. Experimentally, this research uses two degree of freedom shear stress structure and accelerometer as sensor to measure acceleration or deceleration - that is, the rate of increase or decrease in the velocity of a moving object or detecting the vibration on a structure [9]. The accelerometer is placed on the first mass and the second mass of the structure. The excitation force is produced by an exciter which connects to the base of structure. The measurement data is collected by computer and processed by MATLAB R2016a®.

### 1.2 Problem Formulation

In designing a structure, we need to know how big the endurance of a structure toward excitation force. But, measuring the magnitude of the excitation force directly is difficult to do. Moreover, it is impossible to measure in some structure such as: measuring thrust power on a rocket while it takes off; measuring lifted power on a helicopter rotor blade; and many other cases.

And to solve these problems, the former researchers had found a method called as reconstruction force technique. The reconstruction force technique is used to predict the excitation force acts on a structure. This technique is used to finish this final project research.

This research is managed by conducting the simulation program and experimental testing to gather the system response of two DOF shear structure. The system response will be used to conduct the force reconstruction. The simulation program uses MATLAB® software. And the experiment is held by using two DOF shear

structure. This structure will be given some disturbance forces using exciter at the base of the structure and the system response are measured at the each mass of the structure using sensor accelerometer. An algorithm is developed for this force reconstruction. The result of simulation program is compared to the actual result which is obtained from the experiment in order to validate the algorithm of reconstruction technique. Figure 1.1 shows two DOF shear structure model which is used in the experimental study.



**Figure 1.1** Two DOF shear structure

### 1.3 Objectives

The aims of the research:

1. To make simulation program in order to reconstruct the excitation force by using acceleration response and subsequently be validated.
2. To obtain algorithm of a force reconstruction using the vibration system response.

### 1.4 Outcomes

This research delivers the technique of determining excitation force which can be retained by a structure. The force reconstruction technique is applied to a simple shear structure with two degree of freedom. The research will be used as a basic

experimental study of force reconstruction technique on Structural Dynamic Laboratory of Mechanical Engineering Department in Andalas University.

### 1.5 Problem Scopes

Problem Scopes of the research are below:

1. Testing model of this research is using two DOF shear structure.
2. Accelerometer is placed on the first mass and the second mass.
3. The excitation force is applied on the base structure.

### 1.6 Report Outline

The research consists of 5 chapters. Background, research aims, outcomes, limitations and report outline are described in chapter 1. Chapter 2, the literature review, talks about basic knowledge of mechanic vibration and the method of force reconstruction on two DOF shear structure. Chapter 3 describes the flowchart, explains the procedure of research methodology which is consist of simulation and experimental testing, and the use of experimental instruments. Chapter 4 discusses about the results of research. The conclusion and suggestion of this research is served in Chapter 5.

