DEVELOPMENT OF VIBRATION TEST RIG FOR TEACHING AND LEARNING

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A report submitted
in fulfillment of the requirements for the degree of
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DECLARATION

I declare that this project report entitled “Development of Vibration Test Rig for Teaching and Learning” is the result of my own work except as cited in the references

Signature : …….

Name : …….

Date : …….

APPROVAL

I hereby declare that I have read this project report and in my opinion this report is sufficient in terms of scope and quality for the award of the degree of Bachelor of Mechanical Engineering with Honour.

Signature : …….

Supervisor's Name : …….

Date : …….

DEDICATION

To my beloved mother and father

ABSTRACT

Vibration is very important to be learned by the student in order to grasp the understanding of how vibration may bring harm to a system and machine and how it can be controlled and surpassed to get the desire condition. The mass-spring-damper simple model made the learning easy as the system and structure is simplified. In this study, the vibration test rig is developed in order to make the teaching and learning simpler and can be understand easier. In order to do that, the test rig will be design from its frame to make it ergonomics and the parameter used in the test rig will be carefully selected so that the test rig experimental test will be the same as theoretical calculation. The gained information from the past studies and research bring a lot of help in developing the vibration test rig. The imbalanced motor is attached at the centre of the beam with both end of beam is attached to the spring to the top of the frame. The rotation of imbalance motor will causing the beam to periodically move up and down from its equilibrium position which is known as vibration. Accelerometer will be used to determine the displacement of the beam. Later, the absorber will be used which will be attached directly under the motor to be compare to the test without absorber. The result will shows that using an absorber will be able to control the unnecessary vibration to prevent harm to the system. The testing result and theoretical calculation will shows almost the same in their graph shape which represent the vibration of the system when forced vibration with and without absorber is tested. The result shows that the test rig is capable to generate such achievement which will help the student to study vibration and applied the knowledge to the system as they learned in class.

ABSTRAK

Getaran adalah satu perkara penting yang perlu dipelajari oleh pelajar untuk memastikan kefahaman tentang bagaimanana getaran mampu untuk memberi kesan buruk kepada sesuatu sistem dan mesin dan bagaimana getaran dapat dikawal dan diatasi untuk mendapatkan keadaan yang diinginkan. Model mudah mass-spring-damper *dapat membantu untuk memahami dengan lebih mudah kerana sistem dan struktur sudah dipermudahkan. Kajian ini bertujuan untuk membangunkan rig ujian getaran untuk membantu memudahkan proses belajar dan mengajar dan lebih mudah untuk difahami. Penghasilan rig ujian getaran dimulakan daripada mereka bentuk bingkai untuk memudahkan penggunaannya dan penggunaan parameter dipilih dengan berhati-hati untuk mengesahkan rig ujian getaran sama dengan pengiraan teori. Semua maklumat yang diperoleh daripada kajian dan penyelidikan terdahulu telah membantu untuk membangunkan rig ujian getaran. Motor tidak seimbang telah diikat pada tengah rusuk dengan kedua-dua hujungnya disambungkan dengan pegas ke bahagian atas bingkai. Pusingan daripada motor tidak simbang akan menyebabkan rasuk untuk bergerak secara berkala ke atas dan ke bawah dari kedudukan keseimbangannya yang dikenali sebagai getaran.* Accelerometer *akan digunakan untuk menentukan anjakan oleh rasuk. Kemudian, penyerap akan disambung pada bahagian rasuk di bawah kedudukan motor untuk dibandingkan dengan ujian tanpa penyerap. Keputusan ujian akan menunjukkan penggunaan penyerap akan membantu untuk mengawal getaran yang tidak diingini untuk mengelakkan kemudaratan pada sistem. Keputusan ujian dan pengiraan berdasarkan teori*

akan menunjukkan bentuk graf yang hampir sama yang mana mewakili getaran pada sistem apabila ujian dilakukan ke atas sistem untuk getaran yang tiada penyerap dan ada penyerap. Keputusan perbandingan menunjukkan rig ujian getaran mampu untuk menghasilkan keputusan yang memberangsangkan yang mana akan membantu pelajar untuk mempelajari getaran dan menggunakan ilmu dipelajari pada sistem tersebut sepertimana yang mereka belajar di dalam kelas.

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CHAPTER 1

INTRODUCTION

1.0 Background

Vibration is an oscillation of a mechanical system about an equilibrium position. The principle of vibration to work is when an inertia or force element is given onto the mechanical system from its equilibrium position due to an energy transmitted that act as external force to the system (Graham, 2012). There are many small branches under the vibration to be listed such as harmonic excitation, free vibration, force vibration, transmissibility and absorber. Every one of the branches is working directly under the vibration.

Everything that works under the principle of motor will produce the vibration. Even the sound produced as a person is talking is due to a vibration of the sound. However, it is depend on the machine or some parameter to ensure the necessity of the vibration on the system as it has an advantageous and also disadvantageous. As the system is vibrating, it will vibrate at certain set of frequency force. If this frequency corresponds with the system or structure natural frequency, it will cause a resonance that result in fatal big oscillations which is the structure will start to vibrate extravagantly (Nikhil, 2015; Jaini 2014). Some system needs a machine to vibrate at high speed frequency such as screening machine to filter something according to its size and some other system need to reduce the vibration for the machine to work smoothly and reduce the risk for broken machine.

Force vibration occurs when an external force is given or transmitted to the system rather than coming from the system itself which is the natural frequency. As the

mechanical system is at rest, the started motion of unbalance motor will give inertia to the system that will result in vibrational motion. The vibration frequency is started due to the external force known as force vibration.

Generally, transmissibility is a ratio between the amplitude of the force transmitted to the base and the amplitude of the excitation force (Lage, 2014). It also can be known as the ratio when an external force is applied to the system and the corresponding excited by the base. Usually, the transmissibility is control by three parameters which are mass, spring and damper. Each one of the parameter will result in different value and different effect on the system.

Next, absorber is working as a function to absorb a certain force applied to the system and transmit remaining force to the system (Chaudhari, 2017). The absorber also known as the isolator which it absorbs the unnecessary vibration transmitted to the system and reduce the frequency on the system.

As a student learnt about the vibration in the class, student will need a certain way to comprehend the knowledge of vibration for better understanding. Even by looking into the picture and watching the video of the working principle of vibration could not give the student a better understanding as they need something to implement their knowledge to make sure they are truly understand of the vibration. This is where a vibration test rig comes in the hand to help the student.

1.1 Problem Statement

Student has been exposed to the theory of the vibration in the classroom. There are the basic of vibration which is mass, spring and damper before moving on to free and forced vibration, transmissibility and absorber at the end of the chapter. Most student can only see

the effect of the variable of vibration as it work in place without knowing how to implement the theory into real working world as they cannot relate the theory as they cannot see the simple version of those things.

Hence, the objective of this project is to develop the vibration test rig to study the concept of force vibration, transmissibility and absorber as to assists the student to add into their lack of knowledge of the real version of the vibration process and how it work when some parameter is change and the result of the change. Therefore, this project will able the student to be more understands to the vibration subject.

1.2 Objective

The objectives of this project to be achieved are:

I. To design and construct a vibration test rig.
II. To test the performance of the test rig to produce good data of vibration.

1.3 Scope

The scopes to be covered in this project are:

I. To design the test rig by using the CAD software.
II. To develop the test rig according to the design.
III. Test and analysis on the vibration test rig to ensure the functionality of the test rig is the same as the theory.
IV. To assist the student on teaching and learning of the vibration.

CHAPTER 2

LITERATURE REVIEW

2.0 Introduction

This chapter describes the aspect that related to development of vibration test rig. This review method is used to gather and collect the data and any information about the product. All the information will be analyse and review in order to get the better understanding in the development of the product.

2.1 Concept of Vibration

An alternation of physical phenomena where it takes place such as repeating itself as respected to the time are defined as vibration. To put it simply, a repeated motion for an interval amount of times is called oscillation or vibration. Thus, vibration is dealing with a study of oscillatory motion of a bodies and any other force that associated to it.

A machine or its component as it produced a cyclic or oscillating motion from its equilibrium state or its position of rest is known as vibration (Krunal, 2017). Thus, the repetitive motion of a machine which it is repeating the motion from its nominal position is defined as vibration. Vibration is usually dealing with the displacement of the oscillating motion of object in respect to the time (Graham, 2012).

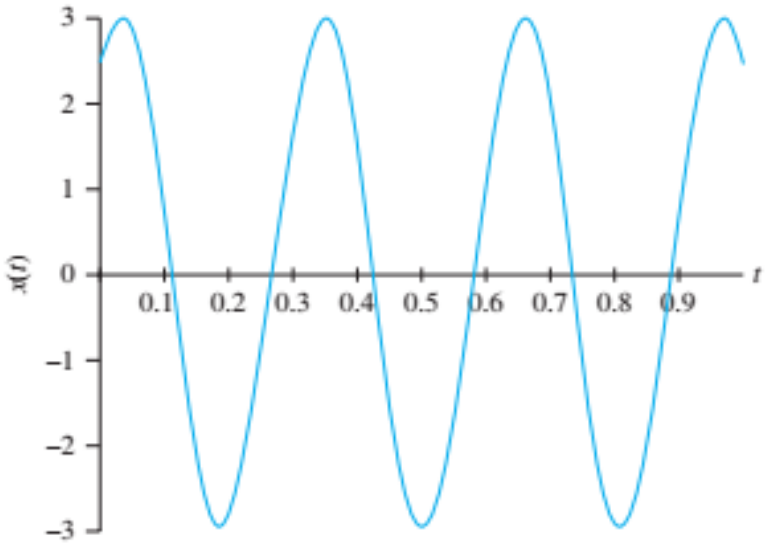

Figure 2.1: Periodic simple harmonic displacement of motion against time

The most common source of vibration that can be seen in everyday life is pump, compressor, vibrator and fans. The excitation of vibration occurs when the centre of mass of the rotating driven part is misaligned with the centre of motor's rotation that causing the centrifugal force to excite outward. The unbalance force that is going outward from its axis of rotation will transfer the excitation force to the other structure connected to the excitation sources causes the vibration. Thus, the eccentric mass and the speed of the rotation of the motor is the keys to determine the characteristic of the vibrations.

Vibration takes place in many structural and mechanical systems that if its unnecessary uncontrollable vibration appears, it could lead to harmful and calamitous situations. So, the vibrations need to be study and understood fully in order to prevent any unnecessary situation as its role is too important in engineering in order to develop a safe design, construction and operation of machine and structure that generally associated with the vibrations (Singiresu, 2007).

By studying the simple mass-spring-damper model, a person should be able to understand the basic of vibration analysis. A complex structure such as bridges could be modeled as an addition of a lot of mass-spring-damper into one complex system. Vibration cases can be classified into several types such as (Graham, 2012; Jaini, 2014);

2.1.1 Damped and undamped

Damped system is where the force is continuously depletes over time as it leads to continual decrease in the kinetic and potential energy with the help of damper. Undamped system is where the vibration oscillated about the rest position and as it reaches equilibrium, the energy is less than the previous reading. Generally, damped system dissipate its energy faster than undamped system.

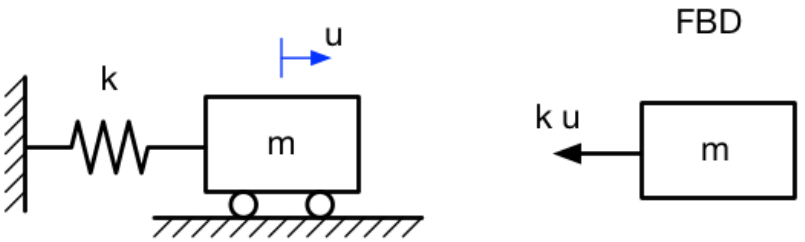

Figure 2.2: Undamped system

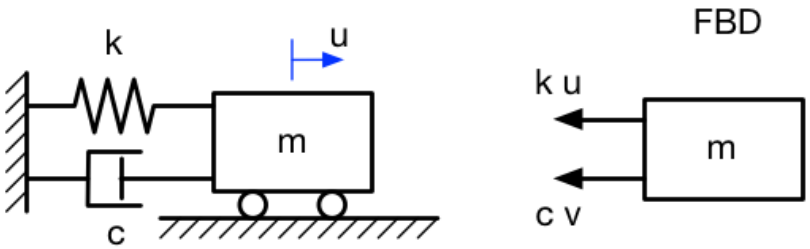

Figure 2.3: Damped system

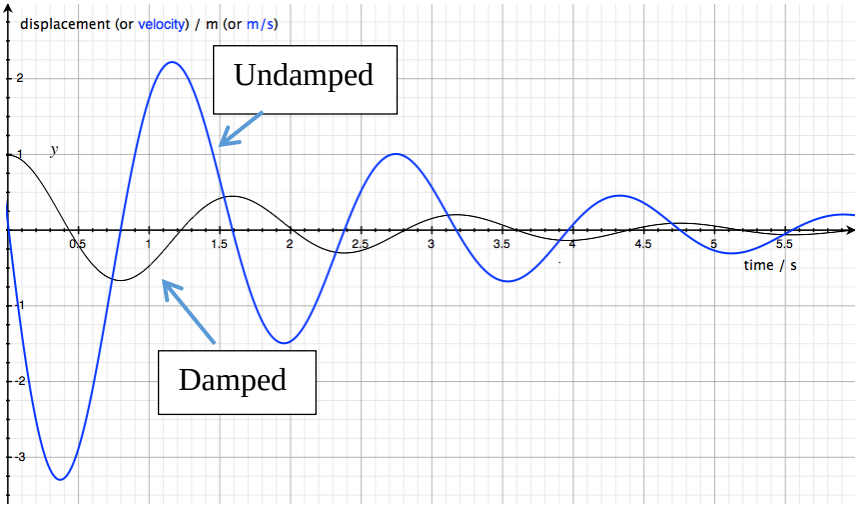

Figure 2.4: Comparison between damped and undamped

2.1.2 Free and force vibration

A system which is oscillated from the equilibrium position in the absence of external force is called as free vibration. However, when the external force is imparted to the system that excited it to cause an oscillation from its rest state is known as force vibration. The difference between both is the present of external force (Graham, 2012).

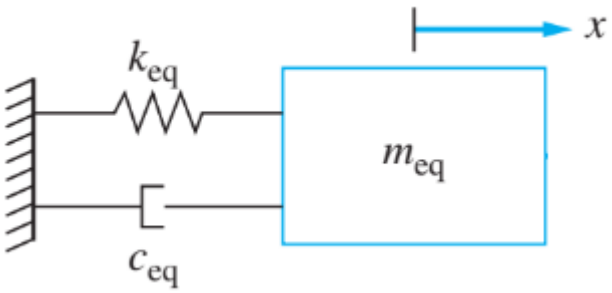

Figure 2.5: Free vibration

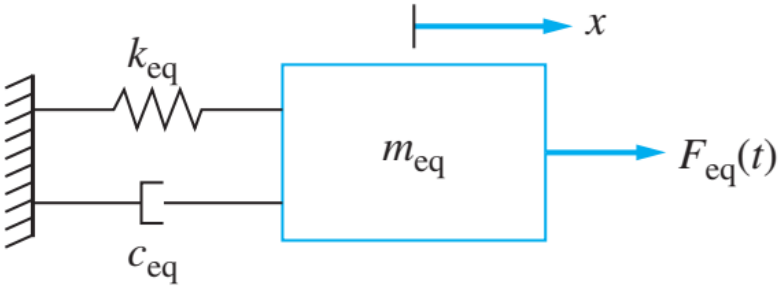

Figure 2.6: Force vibration

2.1.3 Transmissibility

Transmissibility can be defined as the ratio of the amplitude of the response displacement to the amplitude of the displacement forced at the base (Lage, 2014). In other words, it is the ratio of the transmitted force to the force of the base. When the force is transmitted to the base, it will result in the excitation force from the base.

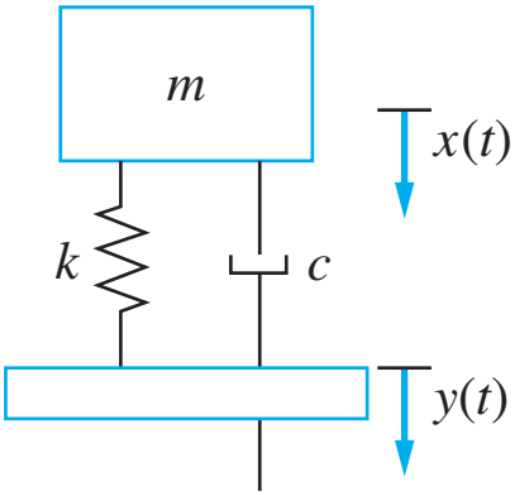

Figure 2.7: Transmissibility system excite the mass and base