1. INTRODUCTION

1.1 Background

A rotating shaft, in general, is known as a rotor and plays a central role in turbo-machinery. It transmits motion to a device or machine. It connects the components that cannot be connected directly due to distance. The rotor is subjected to loading and must be strong enough to withstand this loading. The rotor is employed in critical operating conditions of rotating equipment such as automobile axles, electric motors, steam and gas turbines, wind turbines, pumps, and generators. However, the rotor is considered robust and thriving. In operation, it is usually susceptible to severe defects that develop without much apparent warning [1].

Any deficiencies exist in the rotor, misalignment, unbalance, and losses. These defects are going to excite vibration in rotors. It will not severely affect rotors If the vibration does not exceed the permitted limit. In contrast, it will affect when the vibration is out of tolerance, such as crack initiation.

Crack is known as unintended discontinuities in a shaft (material). They can be grown by operating conditions and environmental factors. In the rotor, cracks are initiated as tiny discontinuities that grow when the component is subjected to cyclic stresses. This size grows in the period resulting in crack propagation and eventually leading to fatigue failure [2].

The vibration responses can change when the crack is present and give a good symptom for crack detection. These changing responses had used by many researchers to detect the crack in the system. Zhou et al. [3] experimentally investigated non-linear dynamic characters of the rotor system containing one transverse fatigue crack. The main point is to put on the effect of crack depth, different eccentricity, and crack angle. Mohamed et al. [4] did the experimental test to examine the vibration characteristics in two different types of cracks in a long rotor shaft, notch cut to varying depths and actual crack growth from a pre-crack. Sinou et al. [5] investigated the changes in modal properties and the influence of cracks breathing on dynamic response. Adewusi et al. [6] experimentally studied the vibration of an overhung rotor with a propagating transverse crack, and the study aimed to obtain the effect of a propagating crack on vibration signals.

The previous researchers mentioned had done experimental and numerical analyzes. They used transverse crack and notch cut as observation, and the rotor has a disk and without a disk attached between bearing. However, very few authors discussed the position of the disk at the tip of the shaft called an overhung rotor. The previous researcher [6] only considered the position of the crack to the vibration responses. Then, there are many types of the crack based on their geometries, such as transverse crack, longitudinal crack, slant crack, breathing crack, gaping crack or notches, surface crack, and subsurface crack [7], as well as these types of cracks will provide the different responses. Therefore, this research will examine the effects of cracked depth with a notch as the artificial crack in overhung rotor model.

1.2 Problem Formulation

Although many studies have been published, more studies need to be conducted on other cracks and model shaft rotors. These cracks and shaft models will provide different responses. So, this research will analyze the vibration responses of the overhung rotor by increasing a certain depth of notch in the shaft at steady-state rotating speed.

1.3 Objectives

The objective of this research is as follows:

1. to obtain the natural frequency of the overhung rotor,
2. to obtain the amplitude of harmonic components of the disk of the overhung rotor both horizontal and vertical directions, and
3. to obtain the orbital shape of the disk.

1.4 Benefits

The benefit of this research is to prevent or earlier detect the presence of crack by comparing the vibration responses between rotor without cracks and existing crack. Therefore, if similar responses are found, preventive action can be taken before leading to enormous failure.

1.5 Problem Scope

The scope of this research is limited to a laboratory experiment. The artificial crack is made by using a saw. The position of the crack is determined, and the depth of the crack is varied. The interference of overhung rotor only focuses on cracking. The other interferences such as misalignment, unbalance, and losses are not considered.

1.6 Report Outline

The research report is divided into five chapters; the first chapter contains the introduction that describes the background, problem formulation, objectives, outcomes, problem scopes, and report outline. The second chapter explains the literature review, which contains the basic theory used in this research. The third chapter, the research methodology, explains the research stage's summary in flow charts, test design, and test procedures. The fourth chapter will present the result of this research. Finally, the fifth chapter serves the conclusions.