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Effect of Gear Transmission System to Vibration Test Machine

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ABSTRACT

This research aims to investigate the vibration analysis for equipment test of chassis. The frame model of the gear transmission vibration test is developed. The prototype of the vibration and noise testing tool was constructed for the gear transmission system. The vibration equipment test consists of three gears that function as a gear transmission. The chassis is considered to be one of the vital elements of equipment. The rotation of gears and shafts can occur the vibration. The simulation with the 3D model using ANSYS was resulted in structure analysis. The simulation was resulted in total deformation, equivalent strain, and equivalent stress where the structure of the equipment was definitely safe and had good stability.

KEYWORDS: *Vibration, Gear transmission, Deformation, Chassis.*

1.0 INTRODUCTION

The vibration in the power transmission system is a major problem, where excessive vibration in the transmission system can cause failure of the shaft, bearing, or gear itself. To reduce the vibration that occurs in the engine transmission system, it is the main target in the manufacturing industry. Vibration is something that is not expected to appear in a working system in a machine installation. Excessive vibration will certainly affect the performance and age of an existing component [1].

People place higher and higher demands on dynamic performance as modern gear transmissions are used more widely and gear technology advances. People are driven to do in-depth research on gear dynamics by the severe requirements on the vibration of gear transmission. People have achieved significant advancements in the study of dynamic features in recent decades, using the gear transmission system as their research subject and progressively applying their findings to the development of gear systems [2]-[5]. The gear transmission system must implement dynamic reactions under the dynamic motivation since it is an elastic mechanical system. The dynamic incentive on the gear transmission system is the primary cause of the gear system's vibration. Therefore, determining the dynamic motivation in the running gear system's process and establishing its shape and character is the main challenge in research on gear system vibration [6].

A spinning mechanism called a gear is frequently employed in numerous industries as a power transmission. Equipment has a lengthy lifespan. The gears, however, are susceptible to damage from a variety of sources, including poor maintenance, one of which is misalignment. The purpose of this study is to ascertain how misalignment affects how vibration, electric current, and shaft rotation speed are transmitted via the gear system. This investigation involved the use of a gear transmission alignment kit, variations of misalignment, and measurement of vibration, electric current, and shaft rotation speed. The study's findings indicate that for all evaluated situations, vibration occurs either axially or radially in proportion to the degree of misalignment. With the slower rotation of the shaft [7].

Over the years, a number of diagnostic techniques, such as oil analysis, vibration signal analysis, particle analysis, corrosion monitoring, acoustic signal analysis, and wear debris analysis have all been used [8],[9]. Acoustic and vibration signal analyses stand out among these studies as popular picks since numerous defects can be found without the machine being stopped or disassembled. These signals' variations frequently imply the presence of a malfunction. Short analysis times, excellent recognition rates, and nondestructive testing are all benefits of acoustic analysis [10]. However, due to a number of factors, including ambient conditions, various recording software parameters, and reflected acoustic signals, it is exceedingly difficult to accurately capture the acoustic signals [11]. The vibration amplitude and frequency, which each reflect the severity and origin of the machine problem, can be used to assess the machine's condition [12].

The human brain of qualified workers combined with the senses of touch and hearing, which serve as a vibration analyzer, can initially assess machine conditions without the

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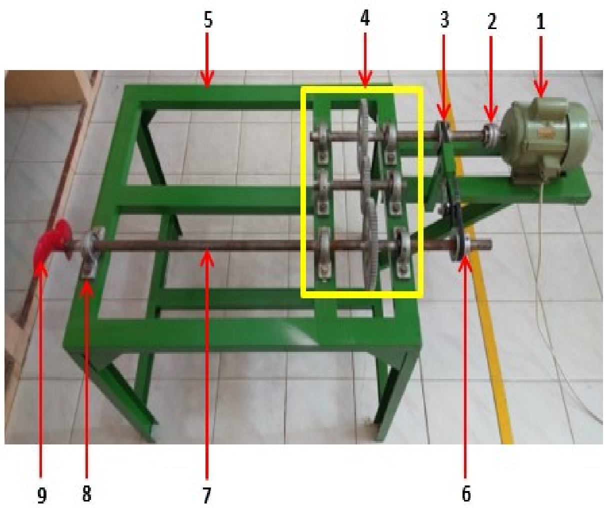
aid of vibration equipment. However, human perception is relatively limited, making it impossible to identify issues that are not detectable by touch or hearing alone. Originally based on a real-time spectral analyzer, vibration analysis can now be divided into three categories: time, frequency, and time-frequency domain [13],[14].

2.0 RESEARCH METHOD

2.1 Test Equipment

The prototype of the vibration and noise testing tool is the construction of the gear transmission system which is the object of this research, which is then used for reference data for 3-D geometry modeling using AutoCAD Software and simulation analysis using Ansys Workbench Software. The construction of the gear transmission system can be seen in Figure 1.



1. Electric Motor
2. Coupling
3. V-belt
4. Gear Transmission
5. Chassis
6. Pulley
7. Shaft
8. Bearing
9. Propeller

Figure 1: Prototype of vibration and noise test equipment

2.2 Forces Calculation

The shaft and gear are supported by two bearings and are loaded by gravity on the shaft and wheel itself. The entire transmission system relies on the chassis as a fixed support. In the figure, it can be seen the construction of the gear transmission system which is based on the chassis.

The loading of gravity on the shaft and gears is calculated based on the reaction force that occurs at the bearing supports, the free-body diagram is first drawn as shown in Figure 2. The results of calculations performed on each variable of the gear transmission system are used as input simulation parameters.

2.3 Reaction force on the propeller

The loading of gravity and the reaction force that occurs in the propeller are according to the layout drawing in Figure 3.

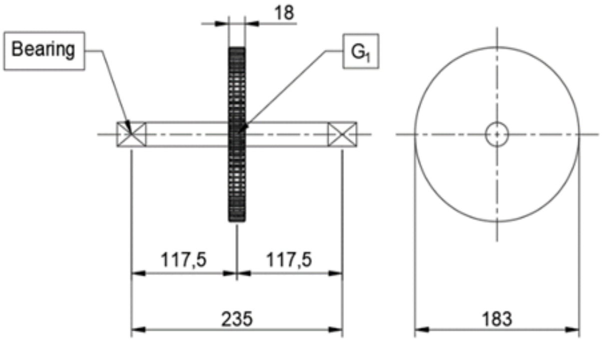


Figure 2: Loads on shafts and gears

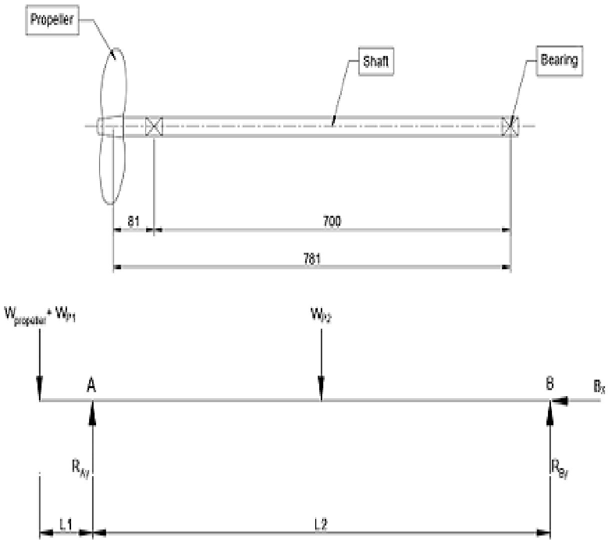


Figure 3: Free body diagram of shaft and propeller

2.4 The 3D Geometry Structure Modeling

By applying reverse engineering, the dimensions of a chassis have been taken from an existing one. For the purpose of determining boundary conditions, dimensions are needed. Its CAD model is required as a result. The typical chassis design utilized in the *Activa* is chosen. Dimensions are determined manually, or through reverse engineering. The 3D modelling of chassis can be seen in Figure 4.

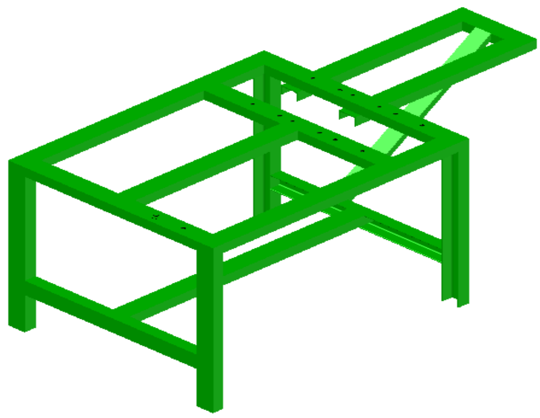


Figure 4: The 3D modelling of chassis

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2.5 Simulation Stage

This simulation process used the Ansys workbench software and then determines the system analysis, namely static structural and interface views, which are the initial appearance of the project schematic. The stages that need to be considered are as follows:

- Modeling of 3-D geometric structures.
- Determine the type of material.
- Meshing process on all components, if it doesn't match, do the meshing process again.
- Determine the fixed support point and loading point.
- Solving process (simulation results)

3.0 RESULT AND DISCUSSION

This simulation was carried out to determine the relationship between vibration and stiffness of the chassis structure from the construction of the gear transmission system vibration test equipment. This simulation is in the form of giving a force that is centered on a construction with bearings. The results of the analysis are the deformation values and contour colors of the structure that will be used as material for analysis. The actual loads that resulted from the equipment test as shown in Table 1, which was carried out, on the gear transmission system used in the prototype vibration test equipment as a research object.

Table 1: Bearing reaction force

Load	Mass Weight	Σ M = 0	
		Σ M_B = 0 (R_{Ay})	Σ M_A = 0 (R_{By})
Gear 1	7,85 N	8,39 N	8,39 N
Gear 2	3,92 N	6,425 N	6,425 N
Gear 3	10,79 N	9,86 N	9,86 N
Propeller	5,886 N	23,15 N	12,16 N

3.1 Deformation Total

The total deformation value received by the structure, with the loading force value input as shown in Figure 5. Where the greater the area of the loading area, the smaller the deformation value that occurs in the structure. After the process is running, the results of the simulation are obtained. In the model of the chassis structure of the gear transmission system, with a load simulation that varies according to the load on each bearing. As a result of the total deformation, the max stress is 0.127 mm and the min value is 0.014 mm.

3.2 Equivalent Strain

The simulation results show the chassis structure model with varying input loading values according to the load of each pedestal. As a result of the equivalent strain, a max stress of 3.858 mm/mm and a min stress of 4.318 are produced. The results can be seen in Figure 6.

3.3 Equivalent Stress

The simulation results show the chassis structure model with input loading values varying according to the load of each bearing, due to the equivalent stress the max stress value is 6.989 MPa and the min stress is 0.779 MPa. The results can be seen in Figure 7.

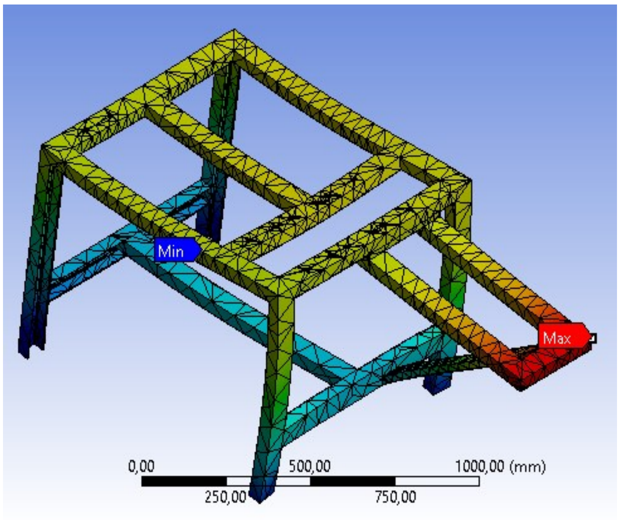

Figure 5: Deformation total of chassis

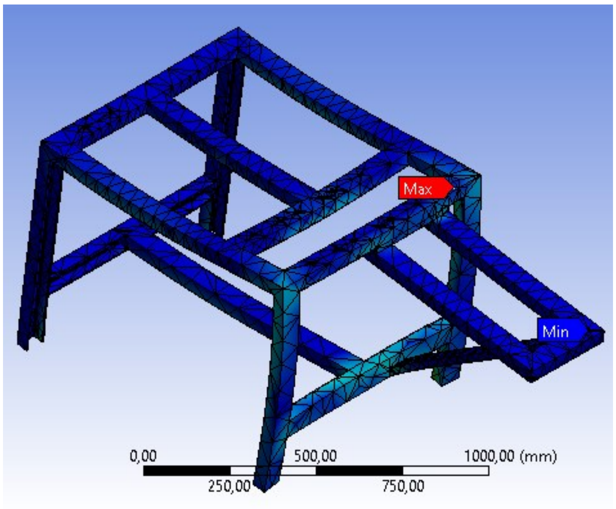

Figure 6: Total of chassis equivalent strain

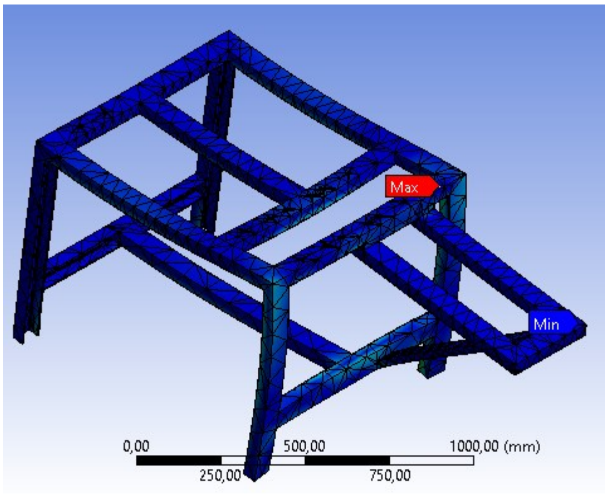

Figure 7: Total of equivalent stress

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4.0 CONCLUSION

Based on the simulation results on the frame model of the gear transmission vibration test tool using Ansys software were conducted. Judging from the results of the analysis of structural statics, that there is a maximum stress between total deformation, equivalent strain, and equivalent stress in the geometry model of the chassis structure of the gear transmission system. The vibrations generated from the gears and the reaction force loads that occur result in deformation, thus affecting the frame structure.

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