Fabrication & Testing of composite tractor trolley chassis

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ABSTRACT

Tractor trolley chassis is a paramount part in automobile sector. The main focus is to identify key performance designators of tractor trolley chassis.This work involves static and vibration analysis to determine the key characteristics of a chassis. The static characteristics include identifying location of high stress area and determining the stiffness of the chassis. This is done in FEA software's (meshing in HYPERMESH, post processing in ANSYS-15). 3D model is to be done in CATIAV5. Predicated on results of stresses and deformation modification is to done i.e.Types Of Chassis Frame to be utilized for better vigor and to reduce the weight of the chassis or design changes can be done to increment its vigor. At last, the amendment of the advanced FE tractor chassis model was suggested to gain the vigor and optimize the weight of the chassis. Further, the model will be fabricated and tested to validate with numerical results.

Keywords: ***Analysis with Ansys-15, Tractor trolley, Principle stresses.***

1. FABRICATION

1.1 Fabrication of composite Tractor Trolley

To prepare composite glass fiber hallow rectangular shaft of thickness 2 mm. glass fiber sheets are catted in proper shapes according to required length,width and thickness then fixed to the skeletal steel rectangular shaft with the help of epoxy resin as an adhesive with the added cobalt 10% cobalt and hardener 10% to increase the rate of drying process as shown in figure below. Once after the process is completed the assembly is allowed to dry for nearly 48 hours then skeletal steel shaft is detached to get complete rectangular cross section glass fiber shaft

Fig-1.1.1: Glass fiber layers used

Fig-1.1.2: Hardener, Epoxy resin and cobalt

Fig-1.1.3: Layers used to form rectangular cross section glass fiber shaft

Fig-1.1.4: Shaft made with glass fiber layers with skeletal steel rectangular shaft inside

Fig-1.1.5: Rectangular cross section glass fiber shaft after detaching

Fig-1.1.6: High strength glass fiber shafted after cutting in to required lengths

Fig-1.1.7: Scale downed glass fiber tractor trolley model

Fig-1.1.8: Glass fiber tractor trolley model for testing

2. TESTING

2.1Experimental / Real time Modal Testing

A basic understanding of structural dynamics is necessary for successful modal testing. Specifically, it is important to have a good grasp of the relationships between frequency response functions and their individual modal parameters illustrated in Figure

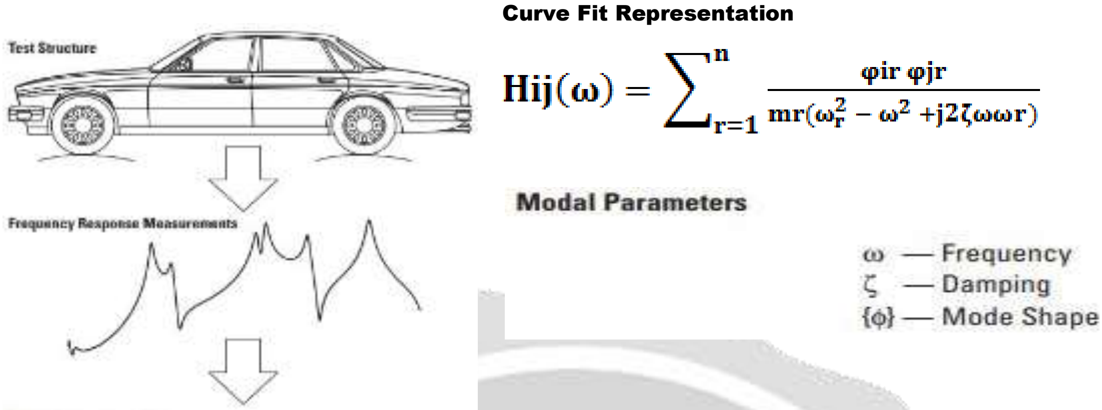


Fig-2.1: Phases of a modal test

This understanding is of value in both the measurement and analysis phases of the survey. Knowing the various forms and trends of frequency response functions will lead to more accuracy during the measurement phase. During the analysis phase, knowing how equations relate to frequency responses leads to more accurate estimation of modal parameters.

The basic equations and their various forms will be presented conceptually to give insight into the relationships between the dynamic characteristics of the structure and the corresponding frequency response function measurements. Although practical systems are multiple degrees of freedom (MDOF) and have some degree of nonlinearity, they can generally be represented as a superposition of single degree of freedom (SDOF) linear models and will be developed in this manner.

First, the basics of an SDOF linear dynamic system are presented to gain insight into the single mode concepts that are the basis of some parameter estimation techniques. Second, the presentation and properties of various forms of the frequency response function are examined to understand the trends and their usefulness in the measurement process. Finally, these concepts are extended into MDOF systems, since this is the type of behavior most physical structures exhibit. Also, useful concepts associated with damping mechanisms and linear system assumptions are discussed.

2.2 Frequency Response Measurements

This chapter investigates the current instrumentation and techniques available for acquiring frequency response measurements. The discussion begins with the use of a dynamic signal analyzer and associated peripherals for making these measurements. The type of modal testing known as the frequency response function method, which measures the input excitation and output response simultaneously, as shown in the block diagram in Figure 1, is examined. The focus is on the use of one input force, a technique commonly known as single-point excitation, illustrated in Figure 2. By understanding this technique, it is easy to expand to the multiple input techniques.

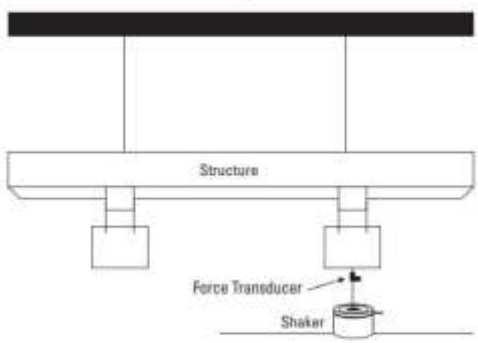


Fig-2.2: Structure under test

With a dynamic signal analyzer, which is a Fourier transform-based instrument, many types of excitation sources can be implemented to measure a structure's frequency response function. In fact, virtually any physically realizable signal can be input or measured. The selection and implementation of the more common and useful types of signals for modal testing are discussed.

Transducer selection and mounting methods for measuring these signals along with system calibration methods are also included. Techniques for improving the quality and accuracy of measurements are then explored. These include processes such as averaging, windowing and zooming, all of which reduce measurement errors. Finally, a section on measurement interpretation is included to aid in understanding the complete measurement process.

2.3 General Test System Configurations

The basic test setup required for making frequency response measurements depends on a few major factors. These include the type of structure to be tested and the level of results desired. Other factors, including the support fixture and the excitation mechanism, also affect the amount of hardware needed to perform the test. As shown below.

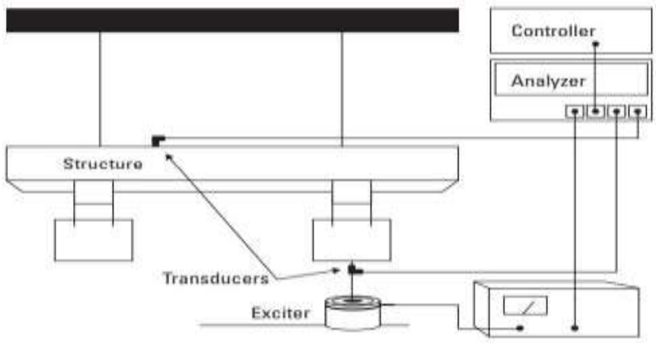


Fig-2.3: Diagram of a basic test system configuration.

The heart of the test system is the controller, or computer, which is the operator’s communication link to the analyzer. It can be configured with various levels of memory, displays and data storage. The modal analysis software usually resides here, as well as any additional analysis capabilities such as structural modification and forced response.

The analyzer provides the data acquisition and signal processing operations. It can be configured with several input channels, for force and response measurements, and with one or more excitation sources for driving shakers. Measurement functions such as windowing, averaging and Fast Fourier Transforms (FFT) computation are usually processed within the analyzer.

For making measurements on simple structures, the exciter mechanism can be as basic as an instrumented hammer. This mechanism requires a minimum amount of hardware. An electrodynamic shaker may be needed for exciting more complicated structures. This shaker system requires a signal source, a power amplifier and an attachment device. The signal source, as mentioned earlier, may be a component of the analyzer.

Transducers, along with a power supply for signal conditioning, are used to measure the desired force and responses. The piezoelectric types, which measure force and acceleration, are the most widely used for modal testing. The power supply for signal conditioning may be voltage or charge mode and is sometimes provided as a component of the analyzer, so care should be taken in setting up and matching this part of the test system.

2.4 Impact Testing

Another common excitation mechanism in modal testing is an impact device. Although it is a relatively simple technique to implement, it’s difficult to obtain consistent results. The convenience of this technique is attractive because it requires very little hardware and provides shorter measurement times. The method of applying the impulse, shown in Figure 4, includes a hammer, an electric gun or a suspended mass. The hammer, the most common of these, is used in the following discussion. However, this information also applies to the other types of impact devices.

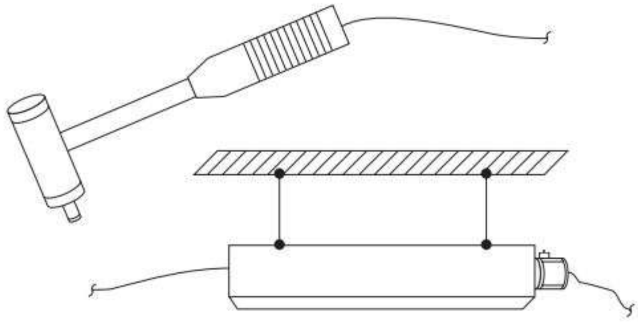


Fig-2.4: Impact devices for testing

Since the force is an impulse, the amplitude level of the energy applied to the structure is a function of the mass and the velocity of the hammer. This is due to the concept of linear momentum, which is defined as mass time’s velocity. The linear impulse is equal to the incremental change in the linear momentum. It is difficult though to control the velocity of the hammer, so the force level is usually controlled by varying the mass. Impact hammers are available in weights varying from a few ounces to several pounds.

Also, mass can be added to or removed from most hammers, making them useful for testing objects of varying sizes and weights. The frequency content of the energy applied to the structure is a function of the stiffness of the contacting surfaces and, to a lesser extent, the mass of the hammer. The stiffness of the contacting surfaces affects the shape of the force pulse, which in turn determines the frequency content.

2.5 General View of Experimental setup:

Measuring the magnitude of vibrations is a useful diagnostic technique for ascertaining that machinery is operating normally and checking for signs of possible problems. FFT analyzer can be used to measure vibration response of a system.

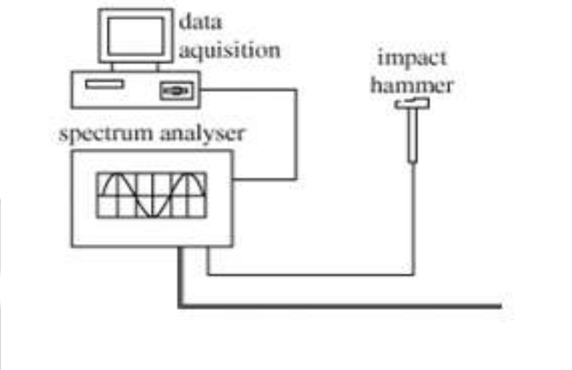


Fig-2.5: Block diagram representation of FFT analyser

- **Sample:**
  It is impacted on the job with accelerometers mounted on it. This accelerometer is connected to spectrum analyzer. Data will be transferred from hammer, accelerometer, to analyzer as a time domain.

- **FFT analyzer:**
  With the data from the sampler, which is in the time domain, this is then converted into the frequency domain by the FFT analyzer. This is then able to further process the data using digital signal processing techniques to analyze the data in the format required.

- **Display:**
  With the power of processing it is possible to present the information for display in a variety of ways. Today's displays are very flexible and enable the information to be presented in formats that are easy to comprehend and reveal a variety of facets of the signal. The display elements of the FFT spectrum analyzer are therefore very important so that the information captured and processed can be suitably presented for the user.

2.6 Experimental testing – FFT Analyzer

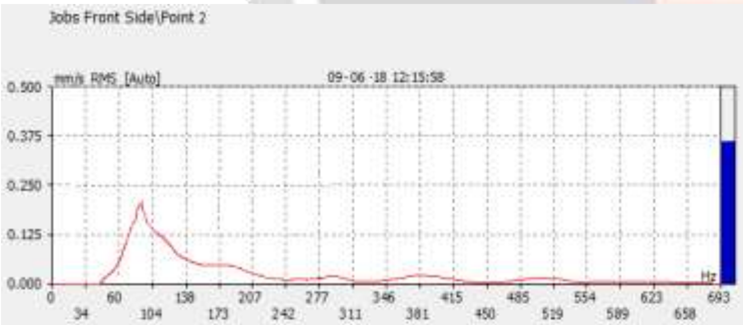
To validate the above modal analysis results, experimental testing has been done with the help of portable FFT analyzer to find out the frequencies for respective modes of vibration. Since the specification of the portable FFT analyzer is restricted. That is the accelometer of FFT analyzer is capable of sensing only translation in any one of the direction. We can carry the test for only x, y and z translations and get the respective frequencies and amplitude once results for three translations gets matched with FEA results. It has been considered that the reaming three rotations will be in good arrangement with FEA results.

Fig-2.6: FFTAnalyzer with Uniaxial Accelometer(transducer)

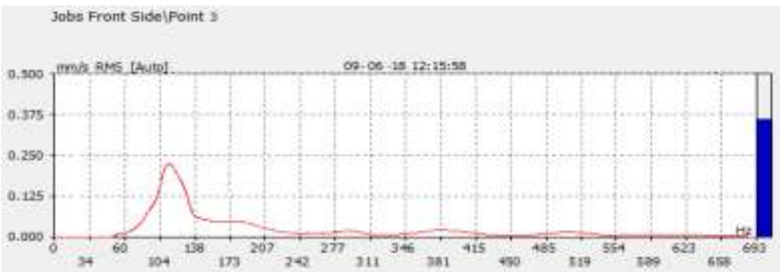
3. RESULT

3.1 Test Plots

Frequency recorded at peak: 47 Hz



Frequency recorded at peak: 90 Hz



Frequency recorded at peak: 112 Hz

3.2 Comparison of FEA and Experimental results

Table-3.2: Comparison of FEA and experimental results

Modes	FEA Frequency (Hz)	FFT Experimental Frequency (Hz)	% Error
Mode 1	47.85	47	1.77
Mode 2	93.62	90	3.86
Mode 3	109.94	112	1.18

From the above compression table we can observe that experimental results obtained by FFT analyzer for first three mode shapes are in good arrangement with respective FEA results. As we observed here, the magnitude of frequencies are comparatively low because of light weight nature of glass fiber and completely fixed boundary condition at the bottom so there are very less chances to vibrate during normal operating conditions to make it vibrate or the resonance to occur with the operating frequency of the vehicle. Vehicle has to vibrate with the high operating speed. So the optimized tractor trolley will be safe under normal operating conditions.

4. ADVANTAGES AND DISADVANTAGES

4.1 Advantages

- Composites are light in weight, compared to most metals.
- Composite materials can achieve excellent strength to weight and stiffness to weight ratios.
- Laminate patterns and ply buildup in a part can be fitted to give the required mechanical properties in various directions.
- Production cost is reduced. A wide range of processes may make composites.
- Composites offer excellent resistance to corrosion, chemical attack, and outdoor weathering.

4.2 Disadvantages

- They are a relatively new material, and as such have a high cost.
- Composites are more brittle than wrought metals and thus are more easily damaged.
- Delamination and cracks in composites are mostly internal and hence require complicated inspection techniques for detection.

5. CONCLUSION

- The comparison shows that the frequencies of vibration of the optimized tractor trolley in six different modes are comparatively low that of existing tractor trolley and stable in vibration point of view
- Even though stress and deformation values of Optimized material are little high compared to existing steel but the values are well below the critical value. Hence, design is safe.
- These modal results are validated experimentally by performing vibration testing of optimized tractor trolley on FFT Analyzer.
- The above study confirmed that the optimized tractor trolley is vibrationally and structurally stable than existing.

6. REFERENCES

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Acknowledgements

Tools and Software Used: (As per requirement)

CAD: Catia v5

CAE: Hypermesh -14

Ansys -15