Glossary

Modal Analysis

Refer to “Method for Reducing Jig Resonance Using Modal Analysis” (page 4)

FUJIKAKE Mitsuhiko, Development & Experiment Sect., Engineering Headquarters, Automotive Components Operations

1 What is Modal Analysis?

All objects and structures have their own natural frequency at which they can easily vibrate. Modal analysis is used to determine how they vibrate at the natural frequency or other frequencies and how they resist external forces. Modal analysis can be used to determine the following:

[1] Natural frequency of target objects and their deformation at the frequency

[2] Natural mode of the target objects

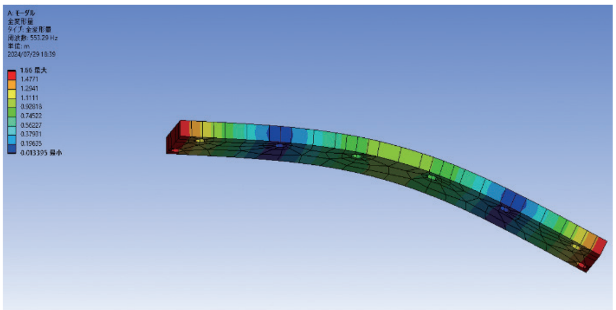
2 Natural Frequency and Mode

The natural frequency of an object is apparent when the object has free vibration. It refers to a specific frequency at which the object can vibrate. The vibration speed is expressed in terms of the number of back-and-forth movements that occur in a unit of time, which is called the frequency. All objects have their own natural frequency. When an external vibration is applied, the object will vibrate strongly with resonance if the external vibration matches its natural vibration. When resonance occurs, the object may emit a large, unusual sound or, in the worst case, break. Therefore, it is essential to avoid resonance. The natural frequency is lower for heavier objects and higher for stiffer objects.

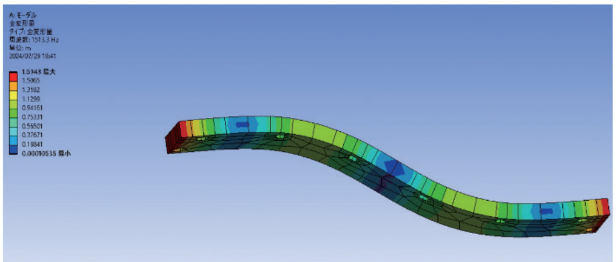
The natural mode refers to the deformation of an object that represents how the object vibrates at its natural frequency. Objects have a fixed shape of deformation at their eigenvalue. The natural mode is called the primary mode, the secondary mode, and so on, in order of increasing frequency.

3 Natural Mode Determined by Simulation Analysis

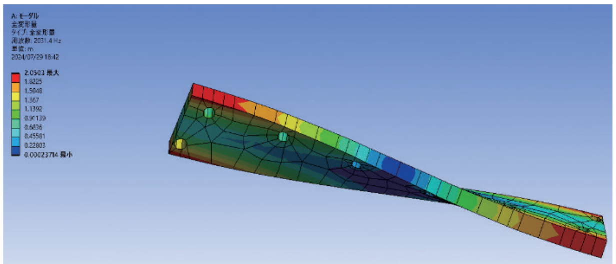
As an example, the following shows the natural modes of a flat bar determined by analysis:



Primary mode



Secondary mode



Tertiary mode

Software used:
ANSYS®

Glossary

Laminated Leaf Valve

Refer to “Enhancing the Accuracy of SA Damping Force Simulation Implemented with AI Technology and Building an AI Operational Management Platform” (page 16).

MANTANI Hiroaki, Gifu Office, CAE Dept., Engineering Div.

1 Laminated Leaf Valve Structure[1]

The automotive shock absorber has a laminated leaf valve (a disc-shaped thin high-tensile steel plate) to vary the oil passage area according to the operating speed of the shock absorber, as shown in Fig. 1. When the shock absorber is operating slowly, the laminated leaf valve remains closed to allow the hydraulic oil to flow into an orifice of a very small area. When the shock absorber operates quickly, the valve is opened and the hydraulic oil flows into the opening.

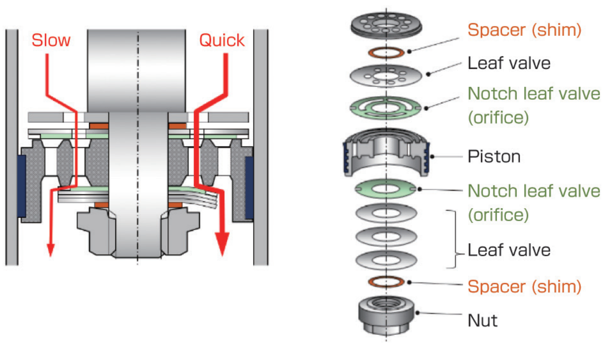


Fig. 1 Structure of laminated leaf valve

The valve structure shown in Fig. 1 realizes the damping force-velocity characteristics shown in Fig. 2. At low operating speeds, increasing the damping coefficient (damping force divided by speed gradient) suppresses the abrupt acceleration and deceleration of the vehicle and the changes in vehicle position during lane changes. At high operating speeds, decreasing the damping coefficient reduces the transmission of vibrations from the road surface to ensure the vehicle's ride comfort.

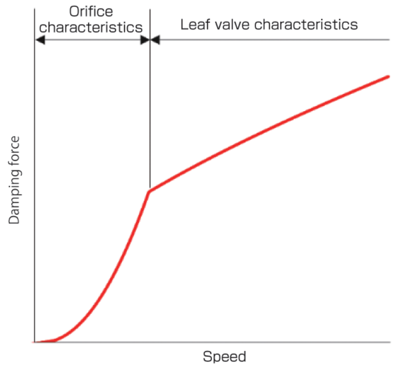


Fig. 2 Damping force-velocity characteristics diagram

2 Required Performance of Laminated Leaf Valve

It is possible to change the outside diameter, plate thickness, and the number of leaves to be laminated to form a leaf valve. A large number of combinations of these elements are available to adjust the damping force in fine increments. In this way, ride comfort can be tuned to the vehicle.

In addition to tuning the ride comfort of the vehicle, the laminated leaf valve, like general pressure control valves, must be hermetically sealed so that the valve cannot be opened until the pressure reaches a predetermined level. In addition, the laminated leaf valve must have fatigue strength so that it will not break during repeated operation, since a broken valve will cause a loss of damping force.

References

1) KYB Corporation: “Automotive Suspension -Structure, Theory, and Evaluation-“ (January 2024).

Glossary

「MLOps」

Refer to “Development of Stamp Inspection Technology Using AI and Construction of MLOps Platform” (page 26).

MITSUO Takashi, R&D Sect. No.2, Production Technology R&D Center, Engineering Div.

1 What is MLOps?

MLOps is a coined term of a combination of Machine Learning and Operations. It refers to an approach or concept for efficient development, implementation, and operation of machine learning models. MLOps facilitates the introduction and use of machine learning at production sites. Specifically, MLOps can be characterized by:

[1] Collaboration between development and operations: Enables development and operations teams to collaborate to facilitate the machine learning processes from model development to operations.

[2] Automation and efficiency improvement: Automates data processing and other tasks to reduce manual task errors and time loss.

[3] Continuous improvement: Monitors machine learning models for performance degradation over time and retrains and improves them as needed to maintain their optimal state.

2 Machine Learning Cycle

Machine learning refers to an algorithm or field of study in which a computer learns from experience to automatically improve itself. Specifically, it is a technology that learns from data and uses the results to perform various tasks (e.g., image recognition, natural language processing, predictive analytics). The quality (predictive accuracy) of a machine learning model can degrade over time due to changes in the environment in which the model was deployed, changes in inspection targets, degradation of data collection sensors, and other factors. Then, a machine learning cycle as shown in Fig. 1 can be performed periodically and continuously to maintain the model quality at a high level to achieve high accuracy stamp inspection.

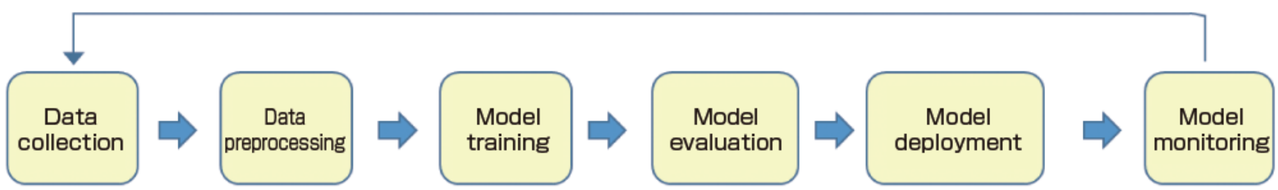


Fig. 1 Machine learning cycle