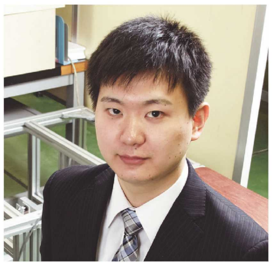
Department of Mechanical Engineering

Key words: Nonlinear vibration, Impact oscillation, Chaos



Doctor of Engineering / Senior Lecturer

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Education

Department of Mechanical Engineering, Faculty of Engineering, Fukui University of Technology
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Professional Background

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Consultations, Lectures, and Collaborative Research Themes

Impact oscillations in mechanical systems

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Main research themes and their characteristics

「Impact oscillations between a pantograph and a rigid conductor line」

The railway current collection system consists of a wire and a pantograph. The contact forces acting on the pantograph can be fluctuated by several reasons. When the fluctuations become large, the pantograph will separate from the wire. Therefore, it is important to prevent the contact loss from the standpoint of long life and the maintenance.

The rigid conductor line is a kind of the wire and is commonly used in tunnel. The wavelike wear on the surface of the conductor line is formed through its longtime use and is a cause of the contact loss. In order to explain the dynamical features of the pantograph after the contact loss, the essential model of the impact oscillations between the pantograph and the rigid conductor line was proposed from the experiments on the actual pantograph system. This model consists of a single-degree-freedom system and the external exciting source that is pushed against the system. Nonlinear analyses show the periodic impact oscillations, the periodic doubling motions and chaos. In the previous study, the flexural vibrations of the pantograph was considered and the effects of flexural vibrations on the bifurcating motions was investigated. In the case that the excitation frequency is near the second mode natural frequency, it is theoretically confirmed that the impact oscillations could be strongly suppressed.

In this study, the coupled oscillatory mass is added to the single-degree-freedom system (main mass) and construct the two-degree-freedom system(Fig.1). I propose the control method to suppress the impact oscillation of a main system. In this method, the controlling force is applied to the coupled mass so that the second mode natural frequency is always near the excitation frequency. As the first step to examine the effects of the coupled system on the suppression of the impact oscillations, the bifurcating impact oscillations was numerically investigated. Moreover, the series of experiments were conducted to confirm the bifurcating motions. When the excitation frequency is near the second mode natural frequency, the experimental results revealed that the impact oscillations could be widely suppressed as predicted by the numerical investigations(Fig.2).

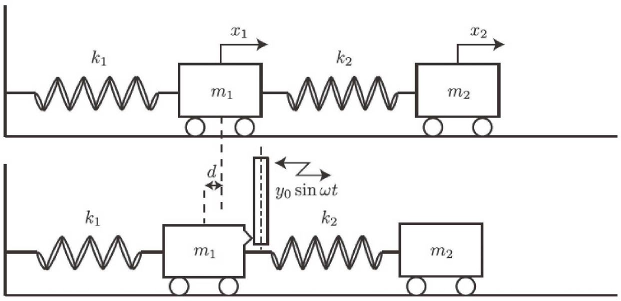

Fig.1 Analytical model of the impact oscillations between a source of external excitation and a main mass coupled with the added oscillatory system. Main mass is subjected to the external excitation source that is pushed against the mass.

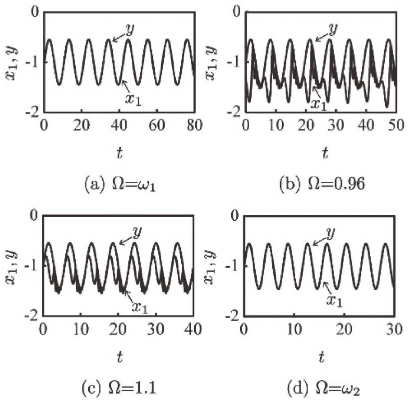

Fig.2 A series of time histories of x_1 and y obtained by numerical calculations considering the added mass.

Major academic publications

Nishiyama, N. and Yamashita, K., Effect of the coupled oscillatory system on impact oscillations between a pantograph and a rigid conductor line, Transactions of the JSME(in Japanese), Vol.86, No.881(2020), DOI:10.1299/transjsme.19-00251.