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相談・講演・共同研究に応じられるテーマ

機械システムに生じる振動

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主な研究と特徴

「パンタグラフと剛体架線の衝突振動」

鉄道車両の集電系として架線とパンタグラフからなる系がよく用いられる。パンタグラフと架線との接触力は常に一定ではなく様々な要因により変動する。接触力の変動が大きくなるとパンタグラフは架線との接触を維持できなくなり、離線が生じる。離線に伴い発生するアークによって損傷する架線の表面には特徴的な波長をもつ波状摩耗と呼ばれる凹凸が生じる。この波状摩耗が成長することにより、パンタグラフと架線の接触力の変動が大きくなり、さらに離線が生じる原因となる。このように、離線および架線表面に生じる波状摩耗の成長の抑制は非常に重要である。

架線の一つである剛体架線とパンタグラフの離線現象を衝突振動ととらえ、剛体架線を定常押し付け力のもとで接触している周期的変位加振源、舟体をばね支持されている1自由度ばね質点系モデルとした研究がこれまで行われてきた。本研究では、1自由度ばね質点系に対して自由度を1つ付加した2自由度ばね質点系の場合について、付加系が衝突振動に与える影響を理論的に明らかにした。その結果、加振振動数が系の2次の固有振動数近傍において衝突振動が抑制され加振源と質点とが接触を保つことを確認した(図1)。

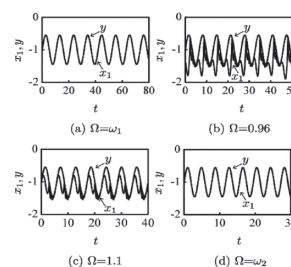


図1. 付加系を考慮した場合の数値計算による代表的な時刻歴

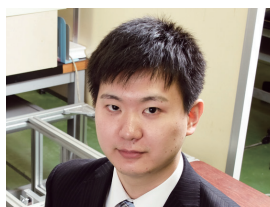
今後の展望

これまで非線形振動や衝突振動の分野を専門としてきた。また最近ではロボット開発の分野に目を向け、制御手法などについて学んできた。現在はバイオメカニクスの分野に興味があり、これまで携わってきた機械工学の制御分野と掛け合わせた学際的な研究を行いたいと考えている。

Department of
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Key words

Nonlinear vibration, Impact oscillation, Control, Biomechanics



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Education

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Professional Background

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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 this study, the coupled oscillatory mass is added to the single-degree-freedom system and construct the two-degree-freedom system. 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.1).

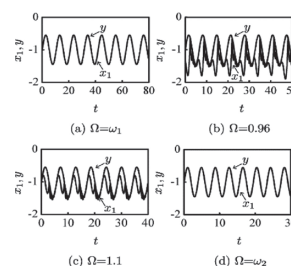


Fig.1 A series of time histories of x_1 and y obtained by numerical calculations considering the added mass.

Future prospects

I have specialized in the fields of nonlinear vibration and impact vibration. Recently, I have turned my attention to the field of robotics development and have been studying control methods. I am currently interested in the field of biomechanics, and would like to conduct interdisciplinary research that combines this with the control field of mechanical engineering, which I have been involved in.