Response reduction using anti-resonance point of seismic isolation device with inertial mass damper

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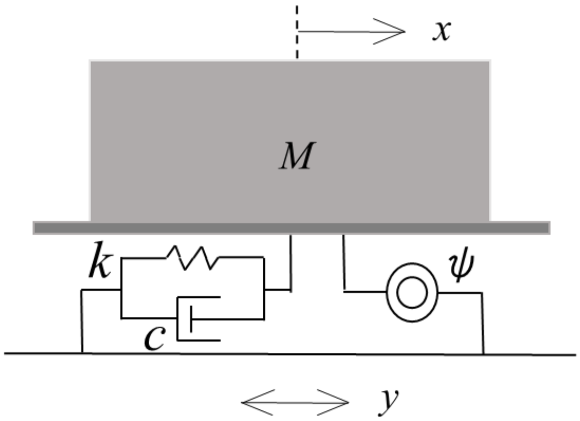
In recent years, active seismic isolation devices have been developed. However, they do not operate when the external power supply is shut off. To solve this problem, a self-powered active seismic isolation device based on the idea of electric power regeneration has been proposed (K. Nakano et al., 2002). This device can control using regenerated vibration energy from seismic motion, and doesn't need external energy to produce control force. However, when long-period earthquake occurs, this device can't regenerate enough electric power to decrease the vibration response. So we propose a new model using a rotating inertial mass damper (inerter) which can decrease vibration and regenerate electric power more effectively than the previous model. An inerter is a device that rotates a weight and can obtain a larger inertial mass than the actual mass. Using power regeneration, a device has been proposed that incorporates a motor in the inerter, and the power regeneration effect is shown by numerical simulation (K. Aoshima et al., 2018).

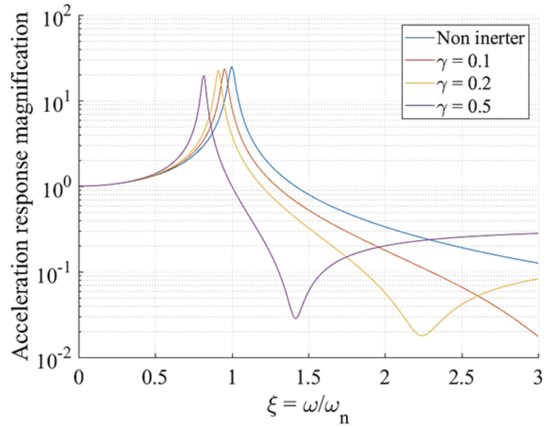
Focusing on the response characteristics in the frequency domain of this model, it is known that there is an anti-resonance point where the response drops significantly. The anti-resonance point changes the degree of response reduction and the value with respect to the frequency when the structural parameters change.

In this research, we indicated the characteristics of the anti-resonance point by differentiating the frequency response curve. And we confirmed that how the structural parameters affect the anti-resonance point by simulation. Moreover, we propose a new design of the device based on an anti-resonance.

Figure 1 shows a seismic isolation model using an inerter, where ψ is the inerter, and γ in Fig.1(b) is the mass ratio of the inertia mass to the mass M. Fig.1(b) shows that when the γ changes, the anti-resonance point changes in the frequency domain. Thus, the position of the anti-resonance point can be changed by installing some elements to the device.



(a) Analysis model



(b) Acceleration response magnification

Fig.1 Basic model

Figure 2 shows the seismic isolation model with more elements, where the red symbols are set as variable parameters. We differentiated the acceleration response magnification of this model, and we indicated the characteristics of the anti-resonance point.

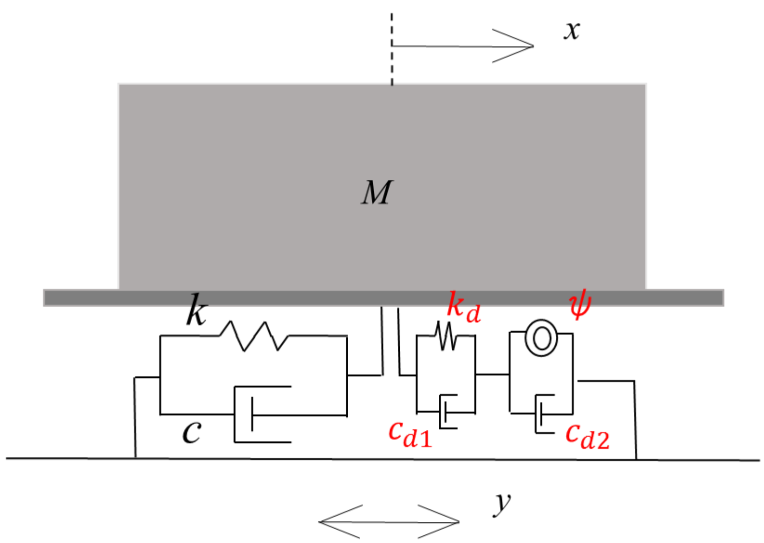


Fig.2 Hybrid model

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