

Sensor-less Combined Vertical and Lateral Magnetic Damper By Using Linear Generator for EDS Maglev

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A linear generator is being developed for the on-board power source of superconducting Maglev. This system generates not only power by using the harmonic magnetic field of ground coils but also magnetic damping by controlling zero-phase current of generator coils. We have studied the characteristics of this system mainly applying to the vertical damper. This paper proposes the sensor-less combined vertical and lateral magnetic damper and investigates its characteristics by numerical example.

Figure 1 shows the composition of linear generator with a combined vertical and lateral magnetic damper. The superconducting Maglev vehicle is suspended by the magnetic force between superconducting coils on board and the fundamental magnetic field generated by levitation coils for the Electro-Dynamic Suspension (EDS) on the ground. On the other hand, the linear generator utilizes its harmonics.

The linear generator coils are located to face levitation coils and connect to make an improved 3-phase circuit. Furthermore, the generator coils in the upper-left and lower-right sides are connected to the converter A, and the generator coils in the upper-right and lower-left sides, to the converter B. The sum and difference of zero-phase currents supplied from the converters A and B can generate vertical and lateral forces for magnetic damping, respectively.

Since the sum and difference of induced voltages in the diagonally-connected coil circuits are proportional to the vertical and lateral deviations of vehicle, respectively, the induced voltage observer shown in Fig. 2 can predict the vehicle dynamics and generate the magnetic damping without detecting sensors.

In order to examine the performance of the sensor-less magnetic damper using a linear generator, we analyze a simple 2-degree-of-freedom vertical vehicle model with car body and bogie.

Figures 3 and 4 show the simulation results of converter and ve-

hicle dynamics, respectively, when the magnetic damper is operated 2 seconds after with a 1 mm and 5 Hz sine wave guideway irregularity (z_2). The predicted induced voltage (E_{00}) agrees with the actual induced voltage (E_0), and the deviation of bogie (z_1) also decreases from 5 mm to 1.4 mm.

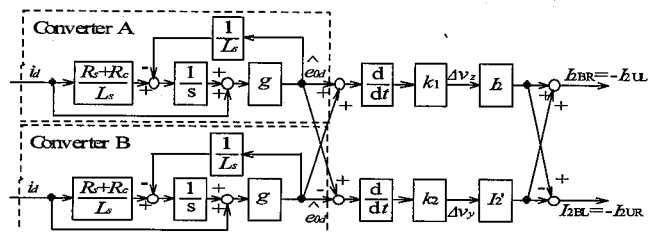


Fig. 2. Block diagram of observer

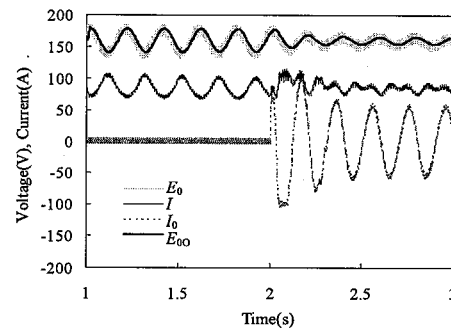


Fig. 3. Simulation results (converter)

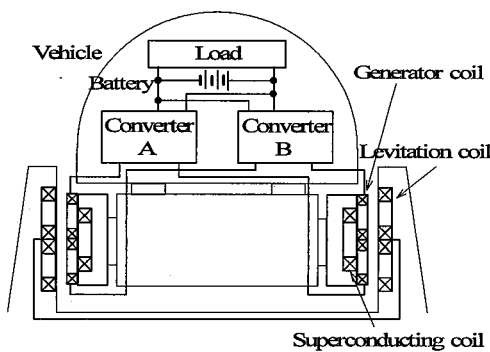


Fig. 1. Composition of linear generator with combined vertical and lateral magnetic damper

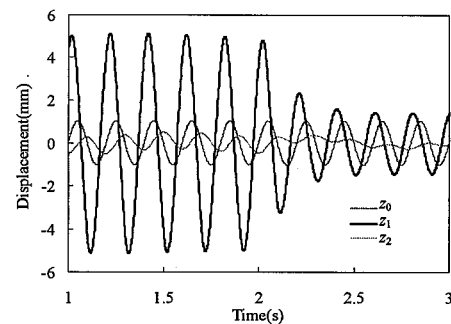


Fig. 4. Simulation results (vehicle dynamics)