Development of Magnetic Rubber Damper with a Constraining Layer (MRDC)

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Recently, with the increase in demand for faster railway cars (from railway users) and for a quieter living environment (from communities along railway lines), there is a growing need to control railway noise and vibration. Of the various railway facilities, steel bridges are one of the major sources of noise and vibration. Accordingly, controlling their noise and vibration has become an important problem. The steel railway bridges are characteristic in that the noise (structure-borne noise) due to the vibration of girder members is extremely loud. Because of this, providing the girder members with a damper has been studied as a measure to reduce the noise and vibration of steel railway bridges. Most conventional dampers are of the type that is bonded to the girder. Since the work with dampers of this type requires a number of processes, including the surface preparation of the vibrating body (base layer), a high-performance damper which offers better workability is called for. Under these conditions, we have developed a magnetic rubber damper with a constraining layer, MRDC, as shown in Figs. 1 and 2.

This new damper consists of a constraining layer (galvanized steel sheet) laminated with a magnetic rubber layer. The magnetic rubber layer is made of butyl rubber with added ferrite powder (particle size: 5 to 10 μm) for magnetization. The constraining layer is used to improve the damper performance (e.g., the shear deformation can be amplified by constraining the magnetic rubber damper). As shown in Fig. 3, MRDC utilizes the magnetic attraction of the magnetic rubber layer to facilitate installing it to the steel vibrating body. The performance of conventional dampers depends upon the internal loss due to the shear deformation of the rubber layer. With MRDC, the internal loss of the magnetic rubber layer is smaller than that of the rubber layer of a conventional damper, but, the frictional loss due to the slide displacement between the magnetic rubber layer and the base layer (vibrating body) comes into action, in addition to internal loss of magnetic rubber layer. Therefore, as shown in Fig. 4, thanks to the effect of frictional loss, which is little influenced by temperature, MRDC retains its high performance over a wide temperature range, whereas the conventional damper shows high performance only within a certain limited temperature range, because of the temperature dependence of the rubber layer.

As shown in Fig. 3, the levels of noise at a steel bridge on a conventional JR line were measured before and after application to the web plate of the main girder of MRDC. As shown in Fig. 5, at a measuring point about 12.5 m from the center of the near-side track, a noise level decline of about 3 dB was observed over a wide frequency range. Thus, it was confirmed that MRDC was effective in reducing the noise produced by steel railway bridges.

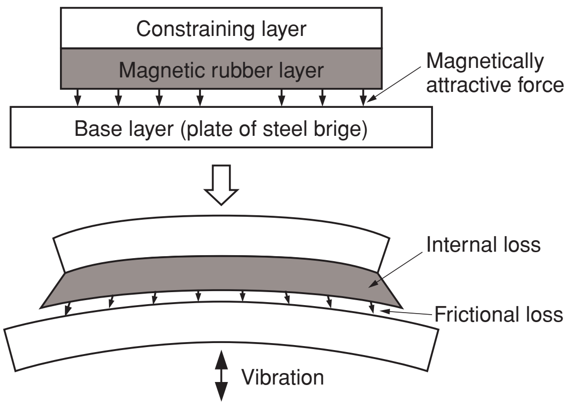

Figure 1. Structure and vibration damping mechanism of magnetic rubber damper with a constraining layer (MRDC).

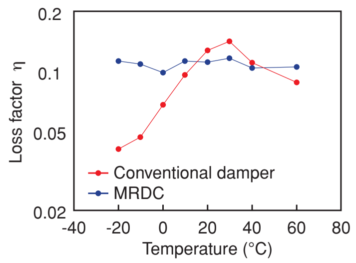

Figure 4. Loss factor of MRDC and conventional damper.

η is loss factor at 500Hz measured by the resonance method with two beam-type samples whose size was 225mm long × 25mm wide × 5.5mm thickness on both sides of a steel beam whose size was 500mm long × 25mm wide × 10mm thickness

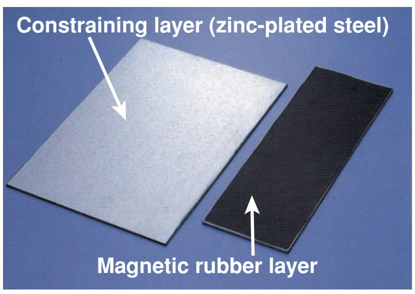

Figure 2. A picture of MRDC.

Figure 3. A picture of installation of MRDC.

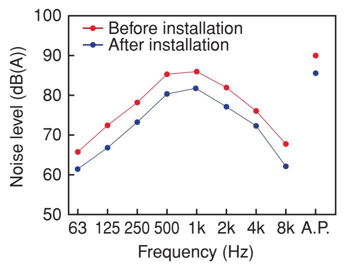

Figure 5. Measuring result of noise level around steel railway bridge before and after installation of MRDC (at a point distant from the center of near side track).