APPLICATION**NOTE**

The Real Performance of Rubber-Metal Buffers During Operation Determined by the High-Force DMA GABO EPLEXOR®

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Introduction

Mechanical vibrations arise naturally from earthquake excitations, e.g., and occur in almost all technical and automotive systems. They considerably affect the survivability of engineering structures, may damage the machines placed nearby, and are often accompanied by disturbing noise. To avoid these disruptions, rubber-metall buffers are used to decouple the main structure from the ground.

In real applications, technical elastomeric products are generally subjected to both: static and dynamic mechanical loads. Depending on the application, the static and dynamic load can vary over a wide range. The static load is quite often related to a product's own weight and may change with time (e.g., passenger car with 1 to 4 passengers, fuel tank: empty or full). Vibrations due to the running engine of the vehicle and driving processes superimpose an oscillating dynamic mechanical load. All static load modes such as compression, tensile and shear can take place.

Transferring such real operating conditions from practice into the laboratory can easily be performed with the High-Force DMA GABO EPLEXOR® system. However, for some applications such as rubber conveyor belts, drive belts or rubber-metal buffers, normal use is characterized by a static pre-load smaller than the actual dynamic load. Such load profiles cause complications for analyzing the mechanical properties of the examined component because a temporary loss of contact between the sample and the sample holder in the compression mode occurs. Correct testing free of artefacts is usually not readily possible in this case.

Thanks to suitable sample holders, the High-Force DMA GABO EPLEXOR® can overcome this technical limitation. Let us demonstrate this with a real application.

Rubber-metal buffers are used for insulating shocks and isolating vibrations. They are made of different rubber materials and are available in many shapes and sizes. Figure 1 shows two different cylindrical rubber-metal buffer types. A rubber-metal buffer with two stud bolts is 25 mm long and has a diameter of 20 mm. A rubber-metal buffer with one stud bolt and one threaded hole is 40 mm long and has a diameter of 40 mm.

Suitable sample holders with extension pieces are used to mount the rubber-metal buffer on the High-Force DMA GABO EPLEXOR®. Figure 2 shows a mounted cylindrical rubber-metal buffer with one stud bolt and one threaded hole on the High-Force DMA GABO EPLEXOR®.

1 Cylindrical rubber-metal buffer with two stud bolts (left) and cylindrical rubber-metal buffer with one stud bolt and one threaded hole (right).

2 Mounted rubber-metal buffer with one stud hole and one threaded hole on the High-Force DMA GABO EPLEXOR®

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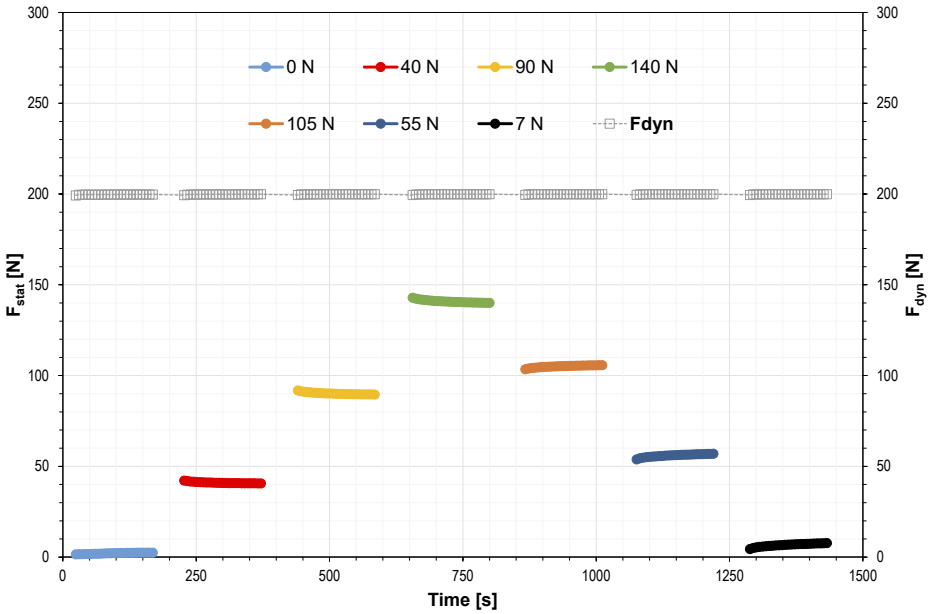
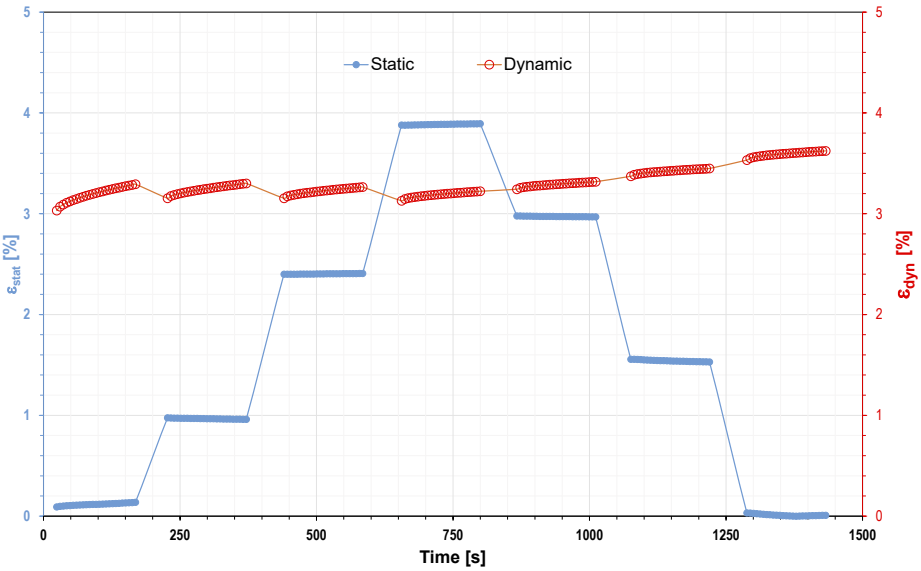
Time sweep was performed at room temperature and a frequency of 10 Hz. The static load was increased in time intervals of 120 seconds in different steps from 0 N to 140 N and then decreased to 7 N. The dynamic load was kept constant during the entire measurement at 200 N. Figure 3 shows the temporal profile of the static and dynamic loads during the measurement, F_{stat} and F_{dyn} respectively.

The existing mechanical strains within the rubber-metal buffer can be derived by taking the geometrical factors into account. Figure 4 shows the static strain ε_{stat} in blue and the dynamic strain ε_{dyn} in red.



3 Temporal profile of the static and dynamic loads applied during the measurement



4 Variation of the static and dynamic strain over time for the rubber-metal buffer with one stud bolt and one threaded hole

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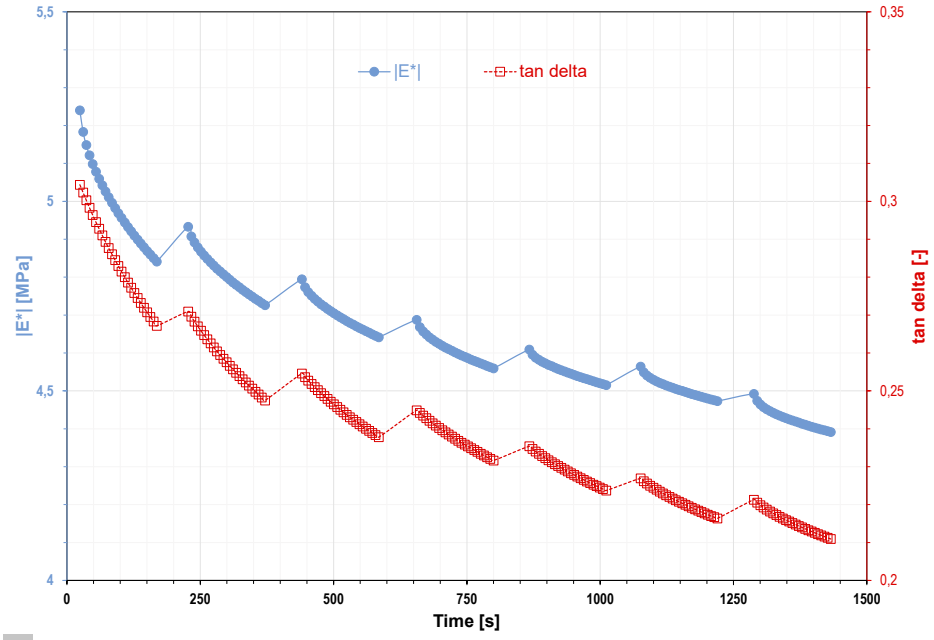

5 Dependence of the modulus of elasticity (left) and loss factor (right) on time for the rubber-metal buffer with one stud bolt and one threaded hole at room temperature and a frequency of 10 Hz

It can be seen that the static strain remains smaller during almost the entire measurement than the dynamic strain. The use of suitable sample holders prevents a temporary loss of contact between the sample and sample holder. Therefore, this measurement setup permits transfer of the real operating conditions of the rubber-metal buffer from practice into the laboratory in a reliable manner. It is now possible to draw reliable conclusions (free of artefacts) about the real mechanical behavior of the rubber-metal buffer during application.

Figure 5 shows the temporal profile of the modulus of elasticity |E*| and loss factor tanδ for the rubber-metal buffer at room temperature and a frequency of 10 Hz. The modulus of elasticity |E*| decreases over time. As a function of the measuring time of the dynamic stress, a time-dependent deformation ε(t) of the rubber-metal buffer occurs. This behavior is reminiscent of creep tests. The creep is associated with an increase in deformation under a constant load (see figure 4). Since the dynamic load is constant over time, according to Hooke ' s law, the modulus of elasticity |E*| must decrease.

The different weights carried, simulated through different static loads, hardly influence the modulus of elasticity |E*| because they are smaller than the dynamic load.

The loss factor tanδ decreases over time because the inner friction is reduced. The sample relaxes.

Conclusion

It was shown that real load situations for applications like rubber-metal buffers – where normal use is characterized by a static pre-load smaller than the actual dynamic load – can be easily tested by means of the High-Force DMA GABO EPLEXOR®.

The High-Force DMA GABO EPLEXOR® provides results that are accurate and free of artefacts due to its versatility and the suitability of the sample holders used. The High-Force DMA GABO EPLEXOR® offers the unique advantage of correctly testing not only simple and basic materials, but also finished products during operation.

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