Investigation of the properties of rubber-metal shock absorbers

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Abstract. The work is devoted to the study of the elastic properties of rubber shock absorbers. Its purpose is to obtain the data necessary for calculation and design. For rubber grades most often used in the manufacture of shock absorbers, graphical dependences "deformation-force" of samples with different ratios of loaded and freely deformed surface, dependence of elastic modulus and a graph of dependence of the ratio of dynamic stiffness and static hardness of rubber (measured by Shore) were obtained.

Keywords: rubber-metal shock absorbers, rubber, shock absorbers

Introduction

In the last decade, the tendencies towards an increase in the power of machines and the productivity of technological equipment with a simultaneous decrease in weight and dimensions, which is achieved by a more efficient use of production space, have become more and more clear. A decrease in the weight of the equipment with an increase in its power leads, as a rule, to an increase in vibration (due to the lack of rigidity of the structure).

Suppression of vibration and noise has become an urgent problem of our time. To solve this problem means, on the one hand, to ensure healthy working conditions, and on the other, to free up additional reserves of labor productivity.

In the fishing industry, vibrations and noises are especially harmful for personnel working with machines and mechanisms installed in confined spaces, such as ship premises of fishing, processing and transport-refrigerated vessels, press-stamping areas, compressor stations, etc.

The cost of manufacturing precisely balanced mechanisms and machines is high and rising sharply with the increasing requirements for precise balancing and overall accuracy, and the cleanliness of machining parts and assemblies of the machine.

The most economical is the way in which certain imbalances of the machine are allowed, and the inevitable vibrations that arise are reduced to acceptable values with the help of shock absorbers.

Static and dynamic tests of rubber compression absorbers

Metal-rubber shock absorbers have a number of indisputable advantages and have a great effect on increasing the service life of machine parts and components exposed to shock and vibration loads.

However, their wider application is limited by a number of reasons resulting from insufficient knowledge of the properties and behavior of rubber as an elastic-viscous shock absorber element under various conditions of its loading.

The literature contains insufficient information required for the design of rubber-metal shock absorbers using different brands of rubber for different operating conditions. The present work is an attempt to obtain some of the data required for this purpose.

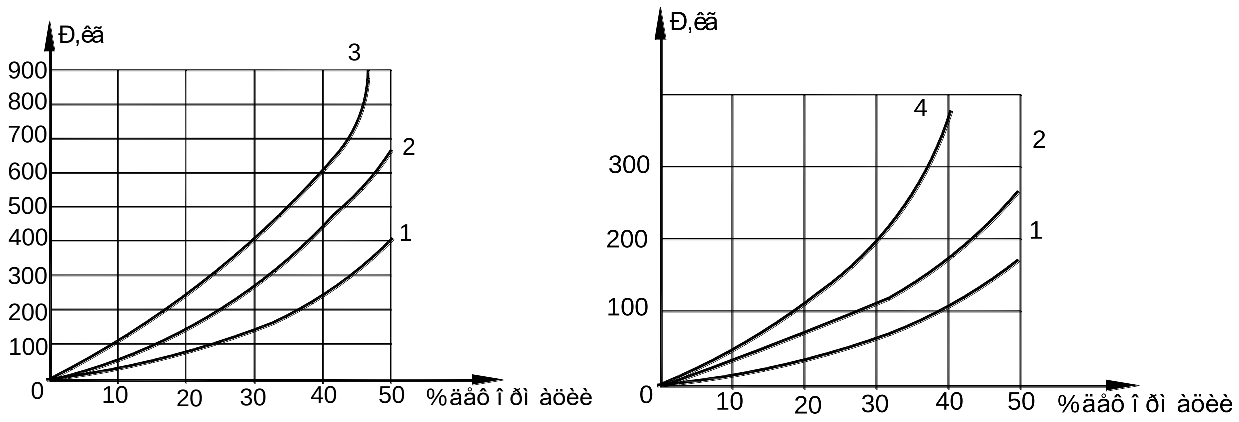
For the study, rubbers of grades 1847, 2959, 2462 and NO-68-1 from natural rubber were taken, as well as samples obtained from raw rubber by vulcanization, for the main characteristic of which their hardness was taken. The samples were in the form of cylinders with a diameter of 50 and 100 mm and samples of square cross-section.

As a result of experiments, it was found that rubber samples after the first loading to a deformation of 50% gave a permanent deformation (settlement) up to 0.5-1.5% of the initial height.

Then, four more loads were carried out up to a deformation of 50%, the size of the specimen in height was stabilized. The original size is restored after removing the load in 4-5 minutes.

Before static calibration, the sample was loaded five times and held after each loading for 5 minutes. Loading speed 50 mm/min.

Calibration results after processing by average values (statistical method) are summarized in a graph (fig. 1).



a b

Fig. 1 "Deformation-force" relationship graph

a) the test piece had dimensions: ∅50 mm and H = 50 mm; b) the tested sample had dimensions ∅100 mm and H = 100 mm, made of rubber 1- 1847, 2- 2959, 3- 2462, 4- NO-68-1.

The scatter of the experimental readings of the efforts from the average ones used in the construction of the graph does not exceed ± 14%.

The modulus of elasticity of rubber, like any elastic-viscous substance, does not remain constant. The rubber itself is practically not compressible. With a load of 2000 kg / cm2, its volume decreases only by 5%.

The activated ability of rubber is manifested only when the rubber under load can freely deform in any direction.

It follows from this that the ratio between the loaded and free surfaces (let's call it the form factor) in a rubber shock absorber has a very large effect on the load-deformation relationship.

Since in conditions under which rubber-metal shock absorbers are made by vulcanization from raw rubber, when the final material of the elastic element in composition and properties may differ from standard rubber grades, it is more convenient to take the Shore hardness of rubber as the main characteristic.

Therefore, we carried out work to study the dependence of the elastic modulus of rubbers of certain ranges of hardness on the form factor.

The tests were carried out on rubber samples of different hardness, namely: 45˚, 55˚, 70˚ Shore.

To avoid errors due to material heterogeneity, the shape factor was changed by decreasing the height of the same samples. The supporting surface remained unchanged.

The loading was carried out on a screw press. The force was changed by a spring dynamometer. Sample sizes in height: 75 mm, 37.5 mm, 25 mm, 18.7 mm, 15 mm. Samples were tested with aspect ratios of 0.25, 0.50, 0.75, 1.00, 1.25, and were compressed by 10% of their height.

The test results after processing are summarized in a graph (fig. 2). As can be seen from the graph, with a decrease in the shape factor, i.e., with a decrease in the freely deformable surface with a constant bearing surface area, the stiffness of the shock absorbers increases significantly.

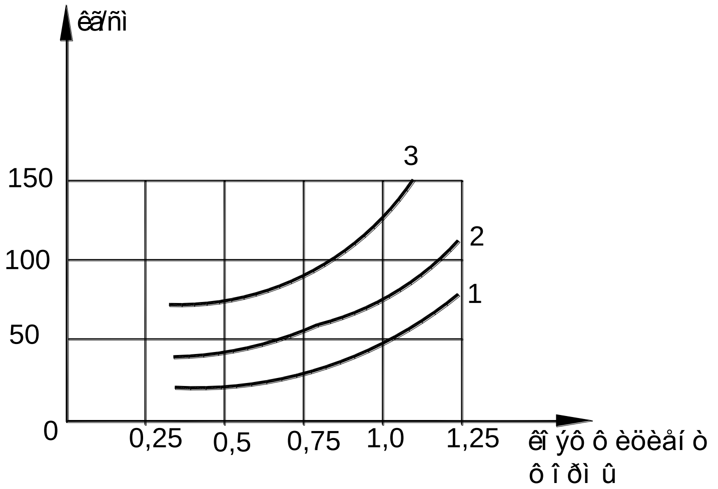


Fig. 2 Dependence of the elastic modulus of rubber in compression of the ratio of the loaded surface to the freely deformed surface for rubber of different hardness

By varying the height of the shock absorber, it is possible to significantly change the static (and, consequently, the dynamic stiffness) of the shock absorber, and then select the most suitable dimensions with a resolution corresponding to the frequency of the exciting force.

Knowing that the effect of vibration absorption by installing machines on shock absorbers depends on the ratio of the frequency of the exciting force to the frequency of the natural vibrations of the system.

The latter depends on the stiffness of the shock absorbers.

The stiffness and modulus of elasticity of rubber under static and dynamic loading are different. Unfortunately, data on the ratio of static and dynamic stiffness (or the ratio of the corresponding modules) are not often found in the literature. Moreover, these data are often different from different sources do not coincide.

Work has been carried out to analyze the technical data of the manufactured rubber-metal shock absorbers. Recommendations for dynamic loads with a frequency of 1000 to 2000 per minute are presented in Figure 3, a graph of the dependence on rubber hardness and the ratio of dynamic to static hardness.

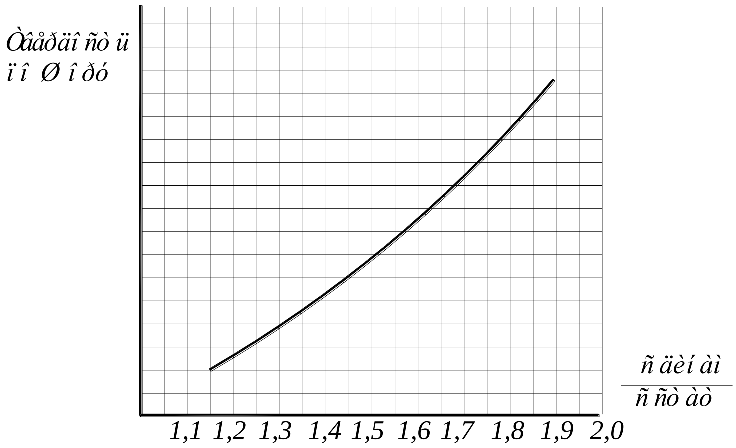


Fig. 3 Ratio of dynamic to static stiffness depending on rubber hardness

Conclusion

The data obtained greatly facilitate the design work in the design of new forms of rubber-metal shock absorbers, as well as in the selection of commercially available shock absorbers for each specific case of machine installation.