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THE DEGREE OF STRESS STATE OF THE RUBBER PART AT VARIOUS TYPES OF STRAIN

***Abstract**: The calculation results of stress-strain state of the rubber part that had the properties of the Mooney-Rivlin model were presented in the article. The degree description of stress state of the rubber part during maximum compression and tension was given.*

***Key words**: rubber, strain, stress, compression, tension.*

***Language**: English*

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Introduction

The rubber products have the special properties. The high degree of rubber elasticity allows using these products at the action of significant variable loads without changing the material volume. Rapidly changing loads applied to the product surfaces are absorbed due to high elasticity of rubber.

The strain degree of the product depends on the physical and chemical structures of material, the mechanism of highly elastic strain and the relaxation processes [1-6]. The value calculation of resistance to destruction under the action of mechanical stresses is performed during tension of the rubber products. Determining the rubber properties is performed on the special equipment and takes some time. Let us consider state of the rubber part that has been subjected to the various types of strain (compression, relaxation, and tension) after implementing the process by the method of finite element modeling. This method of the calculation will allow determining stress and strain state of rubber and getting the dependence between these parameters.

Materials and methods

The rubber part that had the cube shape was subjected to strain. The part was thrown from the certain height onto the flat surface. The rubber part had the properties of the two-parameter Mooney-Rivlin model [7-11]: mass density – 920 kg/m^3; the Poisson's ratio – 0.49; the constant A – 5.4×10^{-4}; the constant B – 4.75×10^{-5}. The part moved progressively down to the plane with the initial speed of 30 m/min. The plane in the research was presented as the absolutely rigid wall.

Sliding between the contact surfaces of the part and the plane occurred without friction. The internal contact (taking into account the material type) that prevents the negative material volumes from being generated was set for the part. The shape distortion of the elements was suppressed by standard viscosity setting [12]. The linear and quadratic volumetric viscosity coefficients were accepted 1.5 and 0.06, respectively. The suppression coefficient during bending the shell element and the suppression coefficient during bending the cross section of the shell were accepted 0.1.

Results and discussion

The strain process of the rubber part consisted of the following stages: initial undeformed state of material, compression, restoring the original geometric shape and tension. The rubber compression process lasted 0.461357 s, the process of restoring the shape lasted 0.79549 s, and the tension process lasted 0.7175 s.

The dependencies of rubber stress from the strain degree during compression and tension are presented in the Fig. 1.

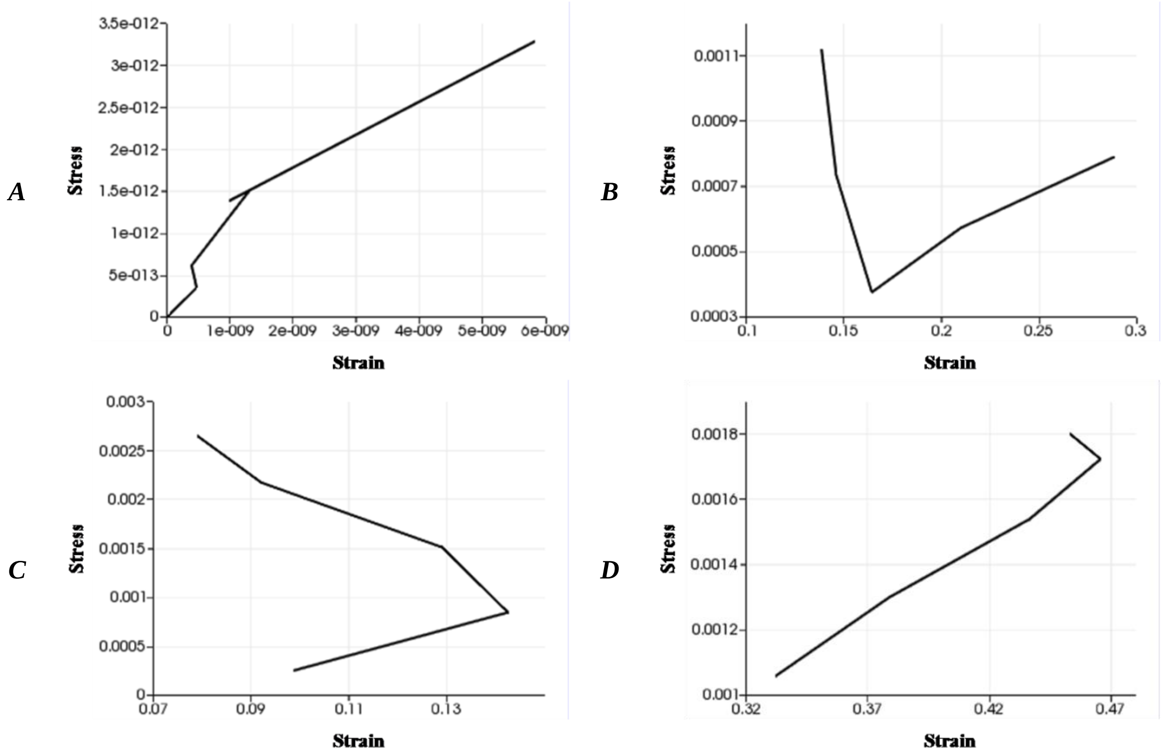

Figure 1 – The dependencies of rubber stress from the strain degree: *A* – the first contact of the part with the surface; *B* – maximum compression of the part; *C* – restoring the original geometric shape of the part; *D* – maximum tension of the part.

The ratio of maximum strain to maximum stress was determined during tension of rubber. Stress in rubber increases in proportion to increasing strain. Rubber is deformed 1.5-2 times less during compression than during tension. The compression process is presented by two phases: the first is sharp decreasing material stress during small strain and the second is gradual increasing material stress during increasing strain by two times. Restoring the shape of the rubber part after compression is accompanied by decreasing stress from the maximum value to the minimum value (relaxation). Strain of the rubber part increases at the beginning of the shape restoring process, and at the process end decreases.

Conclusion

The compression and relaxation processes are accompanied by transient stress-strain state of the rubber product. The mechanisms of changing strain and stress of the product material during compression and restoring the geometric shape are different. The rubber products are recommended using in the compression conditions. Rubber is deformed by 40-50% more during tension.

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