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A NEW CONSTRUCTION AND TECHNOLOGY FOR OFFTAKE TYRES, THEIR DISC FREQUNCIES AND TESTING EQUIPMENTS FOR FATIGUE TESTS

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Abstract
The contents of the paper point out the necessity of combining the theoretical and experimental approaches in the investigation of tyre load in vehicles. The article deals with the loading condition analyse of the manipulator frame for offtake tyres by the working load. The model of the tyre disk was created in software Auto CAD and Cosmos M. There are calculated the first ten eigen frequencies disk in this article with the help of the software Cosmos M. The models are planar and they model the cross-section of the tyre enabling the consideration of the bottom load and the internal pressure in the tyre, as well as the influence of the lateral force.

Keywords
Disc, Natural frequencies, Fatigue, Experimental tests, Reliability

1. Introduction

The model of the manipulator was created in software Auto CAD. The kinematics and dynamics analyse was made in software Working model 3D. The loading condition analyse was made with the help of Cosmos M software.

The discs of tyre casings belong to the main parts of transport vehicles. During the operation they are exposed to a big dynamic load. From their correct function in many cases depends the safety of their operation. The models are planar and they model the cross-section of the tyre enabling the consideration of the bottom load and the internal pressure in the tyre, as well as the influence of the lateral force.

The paper presents the findings, the formulations necessary for solving the task obtained in the experimental model tests and serving as a basis for comparison with the results obtained from purely theoretical approaches, e.g. by the method of finite elements, with identical load conditions.

2. The Ways how to Reach the Solution Goals

2.1 The Manipulator Frame for Offtake Tyres

The loading condition analyse was made with the help of Cosmos M software. The view on the frame for offtake tyres is shown in Figure 1.

Figure 1: View on the Frame for Offtake Tyres

The shift for compression of the frame is shown in Figure 2.

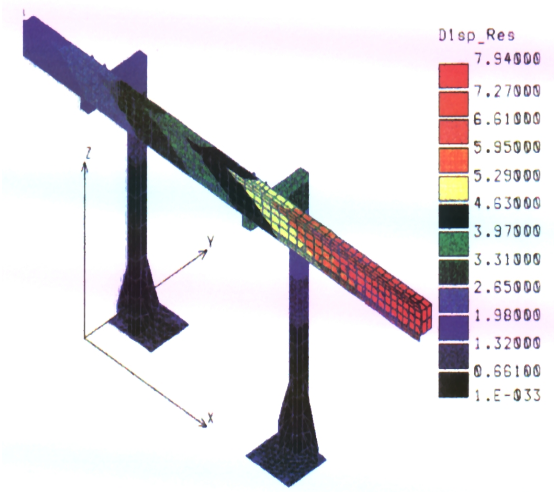

Figure 2. The Shift for Compression of the Frame

2.2 The Model of the Tyre Disk Frequencies

The theoretically calculated shapes of vibration and values of their frequences are not 100% reliable, because the mathematic model is not able to explain all characteristics of the product. Because of these facts, it is necessary to make experimental verifications. The basic static load bearing capacity is 400 kg. The rim thickness is 2,4 mm, and the disc thickness is 3,95 mm.The output temperatures of the semi-products extruded by extruders are $110^{o} – 120^{o}$ C.

The mathematic model of the disc in Fig. 3, was designed in Cosmos M program like a four-nodal thin shell element. Only half of the model was created, as it is symetrical around the centerline. Uder the true vibrations we understand the ability of the system to perform vibrations without the effect of excitated oscillation. The eigen frequences and the eigen vectors are depended on the static parametres of the mechanical system (weight, stiffness, damping, respectively on the grip poin coordinates), it means on structure of the **M, K** matrix. The number of eigen shapes of vibrations is equal to the number of degrees of freedom of mechanical system. The free vibrations of the system represent the basic eigen shape of vibration with the lowest eigen frequency Ω_1. The analysis was executed without the system damping.

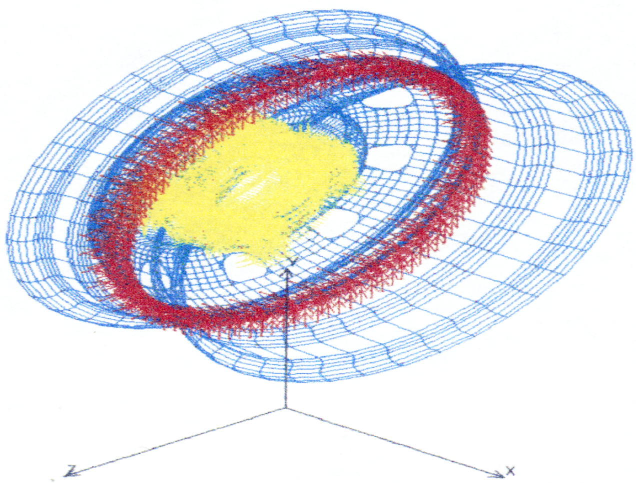

Figure 3: Calculated Model Disc

2.3 Testing Equipments for Fatigue Tests

The steel cords reinforcing motor vehicle tyres are unevenly loaded in time as the tyre is in operation and in contact with the road surface. The conditions for conducting and evaluating experimental tests that would model the considered loading of the steel-cord-reinforced tyre have been defined. To be able to conduct these experimental tests, it was necessary to design simple test equipment for cyclic loading of the test specimens.

2.3.1 The design of the clamping device

The following requirements must be met in the design of the clamping device:

1. high precision and sufficient rigidity of the clamping device

2. possibility of clamping a number of specimens in the clamping device
3. maximal structural simplicity
4. highest possible service life and reliability of the designed structure
5. easy fabricating process of components

The test results may be utilised in developing new models and true to shapes of tyres. The test results may also be used in comparing the efficiency of different testing methods. The theoretical and experimental model tests enable to select the most suitable version in solving the problem of loading the tyres of transport vehicles.

2.3.2 The design of the loading mechanism

The method of the application of load to the specimens by force whose magnitude varies periodically along the sine curve is shown in Fig. 4. The maximum deformation of the specimen is 30% of the functional length of the specimen (77,5 mm), which constitutes the specimen's deformation of (23,25 mm) at the maximum frequency of force variation of 30 Hz.

In order to verify the results of calculation, it is necessary to perform experimental measurements and subsequent evaluations on a greater number of specimens and to modify the calculation accordingly. Items involved here are the actual marginal conditions of the clamping of the specimen, properties of adhesion between steel cord and rubber, magnitude of the loading force and its frequency, the shape and diameter of the steel cord, etc.

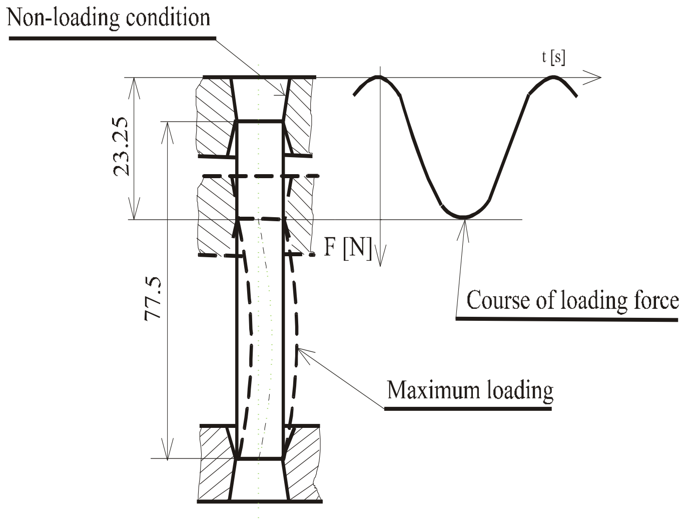

Figure 4. View on the Load of the Specimen

The testing machine enables to clamp the specimen so as to allow to move the steel cord out of the specimen or not, as necessary. The shifts in Fig. 5 are calculated for such compression of the specimen , which will allow moving the cord out of the specimen. The shift is given in metres.

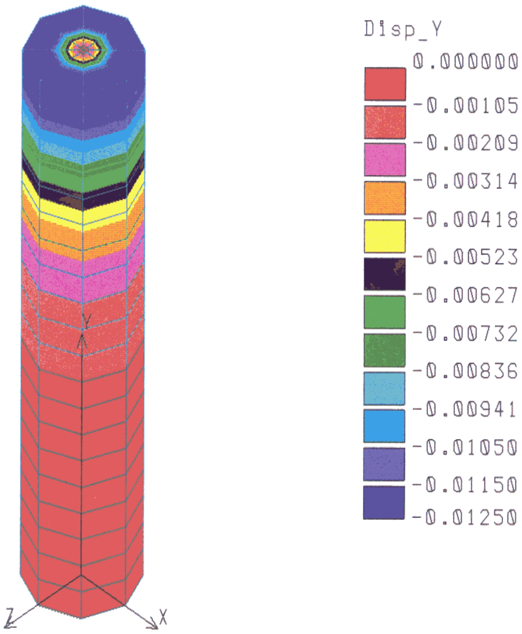

Figure 5. The Shift for Compression of the Specimen

3. Conclusions

It is necessary to verify the results of the analysis with the experimental optic method, with the help of holographic interferometry.

The theoretical and experimental model tests enable to select the most suitable version in solving the problem of loading the tyres of transport vehicles. The test results may be utilised in developing new models and true to shapes of tyres.

The test results may also be used in comparing the efficiency of different testing methods.

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