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SIMULATION OF THE BEHAVIOUR OF A 3D LINK OF A KNITTED FABRIC MADE OF NI-TI TO THE MECHANICAL LOADING

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Abstract: *The models of knitted fabrics are geometrically complicated systems. The simulations of the knitted fabrics models have to include nonlinearities in a form of the geometry, contact and in some case in a form of the material. These nonlinearities increase the computational time. One of the simplifications is the geometrical simplification. The model of the knitted fabric can be transfer from 3D to 2D model. That removes the contact. How large influence has this simplification, we can determine with a model of one link. The creation of this model and the results of the simulation for the link are described thereinafter.*

Keywords: ***shape memory alloy, knitted fabric, non-linear simulation***

1. Introduction

In this article is described a link of a knitted fabric, which is made from Ni-Ti material. Ni-Ti is one of the materials, which is part of the shape memory alloy materials (SMA). SMAs are a unique group of materials, which has the property to recover their shape, when the temperature is increased. Further these materials are capable of absorb large elastic deformations to 10%.

2. Geometrical model

For a creation of a geometrical model of a 3D link of Ni-Ti knitted fabrics is used Dalidovic`s model. This model simplifies the geometry of the knitted fabrics by means of abscissas and semicircles. The geometrical model, which is applied for the following simulations, is in Figure 1.

3. Finite element mesh

The both parts of the geometrical model of the knitted fabrics have an equable geometry, hence the finite element mesh of one thin wire of the knitted fabrics is used for the definition of the second thin wire. The final FE model is shown in Figure 1. The FE model includes 11400 elements of type HEXA20 and 53238 nodes.

4. Boundary conditions

The influence of the friction is observed on two types of the mechanical loading. The first type of the mechanical loading is a tension of one thin wire in the lengthwise direction of the knitted fabrics. The second thin wire of the knitted fabrics is fixed in the initial position.

The second type of the simulations is a tension of one thin wire in the cross direction of the knitted fabrics. The second wire is fixed as well as in the first simulation.

The tension for the both simulations is defined by means of displacements. Maximal displacement is 0,5mm. All boundary conditions are defined on the end sections of the thin wires of the 3D link.

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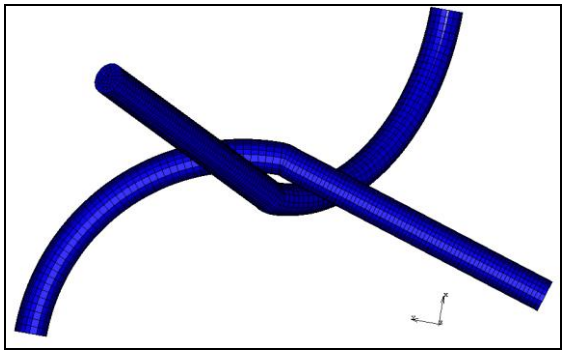

Fig. 1: Finite element mesh and geometry of the 3D link of the knitted fabrics.

5. Results

For both types of the simulations the displacement 0,25mm was assumed. The results for principal stresses, normal stresses and shear stresses are shown in figures 2 and 3.

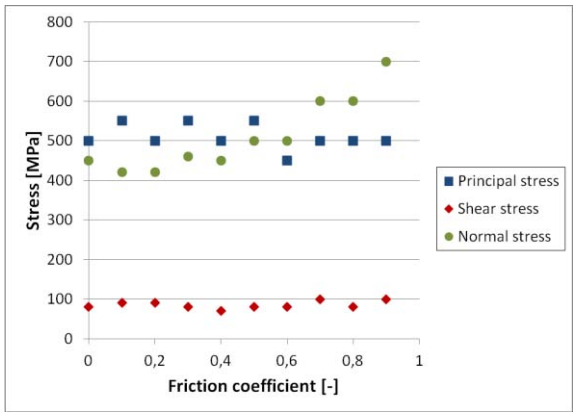

Fig. 2: The stresses [MPa] for the first type of the simulations.

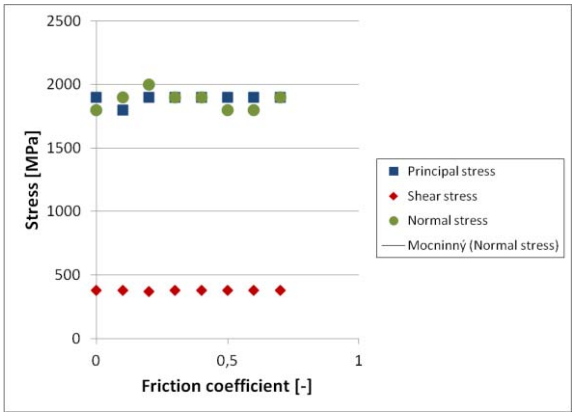

Fig. 3: The stresses [MPa] for the second type of the simulations.

The results show, that only the contact friction force changes in depending on the friction coefficient, which is given the definition of the contact friction force. The contact normal force has large changes, but only for the first type of the simulations and for large friction coefficients, which are unrealistic for our materials. Other variables are unchanging in depending on the friction coefficient.

6. Conclusion

The results of both simulations show, that we can the influence of the friction, if we do not research the friction or heat, which is generated from the friction. Other variables are independent on the friction coefficient. The changes of these variables are shown only for large friction coefficients. The main result of these simulations is the simplified geometrical model of the knitted fabric, which will be used for simulations of large models of the knitted fabrics.

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