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OPTIMIZATION OF THE LINEAR STEPPING DRIVE PARAMETERS

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Abstract

This poster continues the posters presented at the conference Engineering Mechanics 2007 that describe setting up and verification of a calculational model of a control rod linear stepping drive for the reactors WWER 1000.

In the initial phase of the proving experiments of the LKP-M/3 drive upgraded version an excessive wear of the holding pawls occurred. This effect prompted a study of some parameters changes influence on the magnitude of forces acting on the pawls.

There have been three parameters selected for the study, namely the time-point of the retaining electro-magnet contact-making at the lifting, and the stiffness of the springs between the upper and lower suspension bar and between the retaining pawls carrier and the lifting system.

Description of the equipment, principle of the drive operation, calculation model, modal analysis results, and calculation results of the preparatory phase, lifting and lowering heights were presented in two posters at the conference Engineering Mechanics 2007. These results include displacements, velocities, and accelerations time-history of the LKP-M/3 main parts as well as the establishing their acceleration maxima and the corresponding distribution of stresses in the calculational model.

The optimization was carried out for the cluster mass of 27 kg and for the lifting height at which the pawls are loaded a lot more. As first, an unknown damping according to the measurements (Václavík, 2006) was chosen. The lifting height was subsequently modified in such a way so as the initial conditions were in line with those at the measuring.

The optimization of the time-point, at which the retaining magnet makes contact, and the stiffness of the springs between the upper and lower suspension bar and between retaining pawls carrier and lifting system was performed on the calculational model modified in the way suggested.

Conclusions for the shift of retaining electro-magnet contact-making time-point:

- negative (fast) shift of the retaining electro-magnet contact-making time-point did not bring desired improvement,

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- positive (slow) shift of the retaining electro-magnet contact-making time-point brings a marked improvement,
- proper interval for the shift of the retaining electro-magnet contact-making time-point ranges from +0.025 to +0.05 seconds relatively to the initial setting,
- the shift of the retaining electro-magnet contact-making time-point proposed (based on measurements Václavík, 2006) to be +0.04 s is quite feasible as all parts of the LKP-M/3 are now subjected to a very low stressing,
- in terms of the live loading of the upper suspension bar (and of the pawls in consequence), all shifts of the retaining electro-magnet contact-making time-point in the interval +0.025 to 0.05 seconds are in practice of equal validity and an applicable value can be chosen by virtue of additional considerations.

Conclusions for variation of the springs stiffness between upper and lower suspension bar:

- changes of the spring stiffness between the upper and lower suspension bar varying from -20% to +20% of the initial value do not substantially impact on the pawls stressing,
- the accelerations of the upper suspension bar are greater in case of changed stiffness than they are with the original stiffness of 27900 N/m,
- the forces acting on the pawls, and consequently also their wear, are directly proportional to the accelerations,
- a stiffness change less than +5% was not analyzed since it is technologically impossible to manufacture a spring with such a small stiffness deviation,
- the stiffness of the springs between the upper and lower suspension bar is tuned optimally with respect to the pawls stressing. Changing the spring stiffness cannot decrease it.

Conclusions for variation of the springs stiffness between the retaining pawls carrier and the lifting system:

- optimal stiffness of the spring between the retaining pawls carrier and the lifting system is 20000 N/m,
- the benefits of this change are however markedly less than those brought by the shift of the retaining electro-magnet contact-making time-point between +0.025 and +0.05 s.

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