APPLICATION OF THE MODAL ANALYSIS TO MODELLING THE CRANE TELESCOPIC JIB

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In the paper a modal method is used to model a telescopic jib. The model takes into account the fundamental dynamic properties of the jib. Application of the modal method requires knowledge of the several lowest frequencies and forms of free vibrations of the system. The problem has been solved by using our own computer program that is based on the finite element method. The results of numerical calculations were compared with the results obtained for the jib modeled in Ansys. The model of the jib is used to formulate an analytical model of the crane. This approach enables an efficient numerical model for a complex mechanical system to be obtained. Results of numerical simulations of the dynamics of the whole crane are presented as well.

Key words: *mobile crane, modal analysis, dynamics, telescopic jib*

1. Introduction

Numerical efficiency of mathematical model of complex systems is one of the most important criterion in evaluation of the usefulness of the model in calculations. It is obvious that models used in control problems have to be much 'faster' than models used in analysis of structures. The quality of a model is related to:

– correctness of description of the main features of a considered system,
– its numerical efficiency.

A jib is a very vital subsystem of a mobile telescopic crane. The method of its modelling has great influence on results obtained as well as on time of calculations. The jib models that are presented in literature have a varying number of degrees of freedom. Various methods of jib discretization are used and various phenomena of the system are taken into consideration. Balkan [1] and Towarek [2] modelled the jib as a rigid beam. Posiadała [3] used Bernouli-Euler's model of a beam, Rusinski [4] used the finite element method (FEM). In [5] Kilicaslan et al. treated the jib as a flexible body modelled by FEM and used modal variables. Modal analysis based upon FEM is an excellent method. In the paper the application of a modal method to modelling a telescopic jib is presented.

2. Description of the modal method

Fig. 1 presents a jib modelled as a supporting beam with variable cross-section. Taking into account that transverse vibrations of the jib in planes X0Y and X0Z are independent, deflection of a particular point of the jib centre line can be written in the following form:

$$\begin{aligned} u_{\mathrm{y}}(t,x) &= \boldsymbol{\eta}_{\mathrm{y}}^{\mathrm{T}}(t)\,\mathbf{S}_{\mathrm{y}}(x)\ , \\ u_{\mathrm{z}}(t,x) &= \boldsymbol{\eta}_{\mathrm{z}}^{\mathrm{T}}(t)\,\mathbf{S}_{\mathrm{z}}(x)\ , \end{aligned} \tag{1}$$

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