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Modelling of dynamical systems in transportation using the modyfit application

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Analysis and modelling

ABSTRACT

Purpose: of this paper is to present a numerical application for analysis and modelling dynamical flexible systems in transportation. This application enables controlling and regulation of rotating systems with the interaction between the working motion and local vibrations of elements.
Design/methodology/approach: Numerical calculations are based onto mathematical models derived in other publications. The objectives of making this application were connected with emerging wants of analyzing and modelling rotating systems with taking into consideration relation between main and local motions. Theoretical considerations were made by classical methods and by the Galerkin's method.
Findings: In way of increasing the value of angular velocity we can observe creating additional poles in the characteristic of dynamical flexibility and after increasing it is evident that created modes are symmetrically propagated from the original mode. It is evident, instead of modes there are created zeros.
Research limitations/implications: Analyzed systems were limited to simple linear type beams and rods. Main motion is plane motion. Future research should consider complex systems and nonlinearity.
Practical implications: of the application are possibilities of numerical analysis of beam and rod systems both the free-free ones and fixed ones. Engineers thank to this application can derived the stability zones of analyzed systems and can observe eigenfrequencies and zeros in the way of changing the value of angular velocity. In practice we should implement more adequate models such as those presented in this paper.
Originality/value: This paper consist the description of the application called the Modyfit. The Modyfit is an implementation of derived models in a numerical environment. Those models are rotating flexible systems with consideration the transportation effect.
Keywords: Numerical techniques; Computational mechanics; Applied mechanics; Transportation effect

1. Introduction

In this thesis considered problems apply to vibrations of beam and rod systems in rotational transportation. In the literature [2-6, 12-13] there are publications connected with the subject area of vibrating systems in transportation as distinguished from ones connected with the stationary systems [1, 7-11, 14-19]. There are considered rotational motion treated as transportation and there are derived equations of motion and on this basis there are assigned the dynamical characteristics in form of the dynamical flexibility. At present the main aim of analysis is derived in this articles the attenuation-frequency characteristics. A group of considered systems was made by including models of beams and rods rotating onto the one of planes of global reference frame. As input functions there were accepted the harmonic transverse forces that generate flexular transverse vibrations and the harmonic axial forces that generate longitudinal vibrations. The solution of the vibrations analysis of systems in motion can be objective of practical applications on a large scale. As example applications we can represent many technical systems such as wind power plants, different kind of turbines, actuators used in different types mechanisms and machines, rotor systems, and also airplanes and helicopters, etc.

The solution of systems is mainly bounded with mathematical problems, therefore there is decided to use an approximate method, specifically the Galerkin's method. With the help of this method there were derived dynamical flexibilities of analyzed beams and rods, before comparison of effectiveness of given method in case of solution stationary systems as particular case of rotational systems with the angular velocity equal zero. In domain of those systems there were not noted meaningful differences between solutions of systems using the accurate method and solutions of systems using the approximate method. On this basis there was accepted the Galerkin's method as a sufficient method for aims of analysis of systems in motion as well. Also because of this reason the solution was made in the form of dynamical flexibility presented as infinite series. The thesis shows the mathematical model of an unquestionable effect of transportation onto dynamical characteristics. It is relatively new approach of analyzing those type system and can be put to use in modelling and dynamical analyzing beam and rod systems in rotational transportation.

2. Description of the numerical application "Modyfit"

In this section there was presented and described the Modyfit application. Application can be put to analyze both of systems in transportation and stationary ones. Research of behaviour of systems was made by changing of their characteristic parameters applying to work, there is also a possibility of steering of geometrical features and physical features. The print of main screen of the program that presents his graphical interface was illustrated on Figure 1.

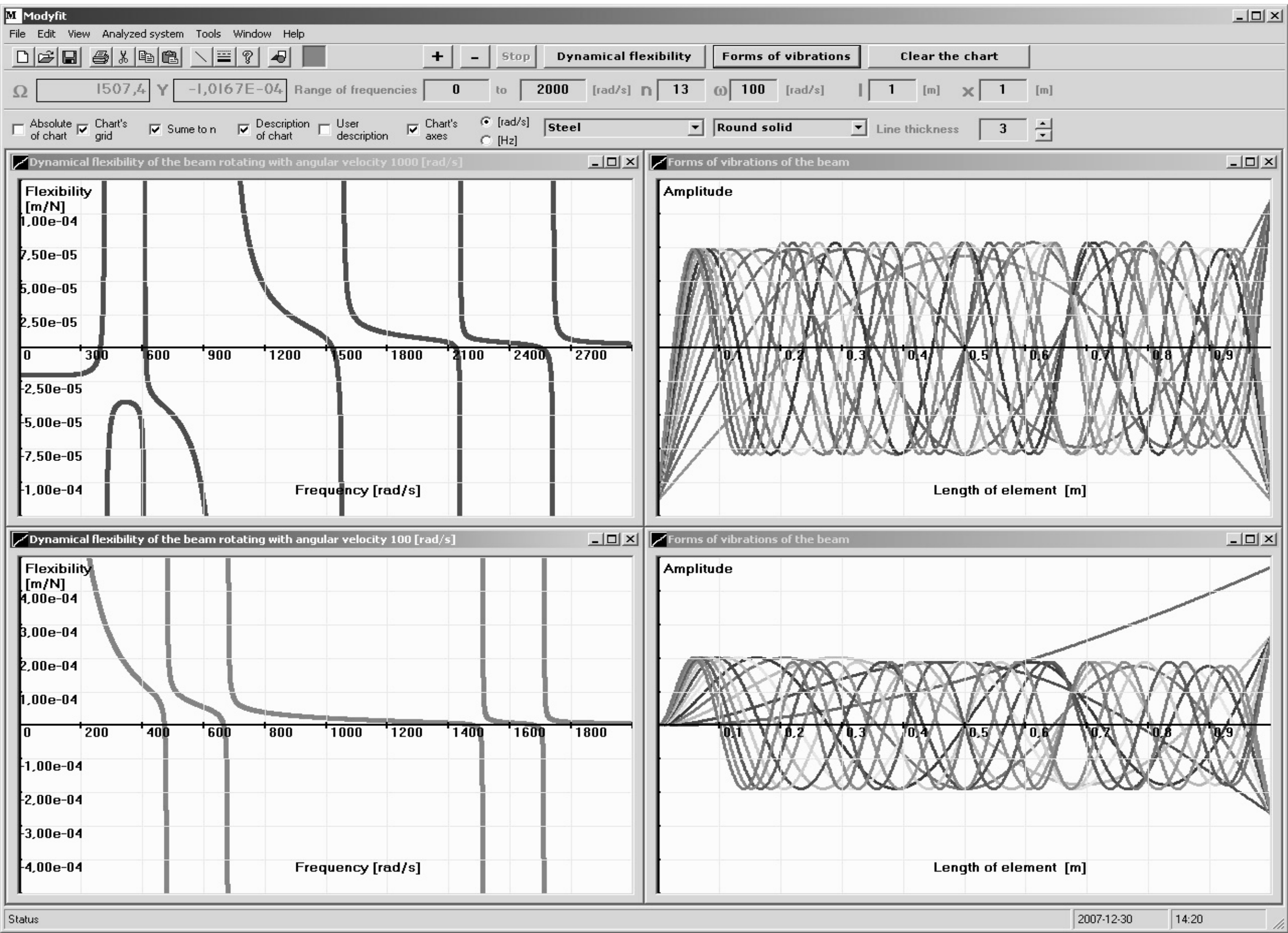

Fig. 1. Main screen of the Modyfit application

3. Example characteristics

3.1. Dynamical flexibility

The Modyfit application gives a possibility to generate dynamical characteristics of beam and rod systems both stationary ones and moving ones. In this subsection there is presented the example characteristics of systems in transportation. The characteristics concerns the beam system in transportation (fig. 2) and the rod system in transportation (fig. 3). In the figure 2 the dynamical flexibility of the fixed beam rotating with angular velocity equal 100 rad/s was presented.

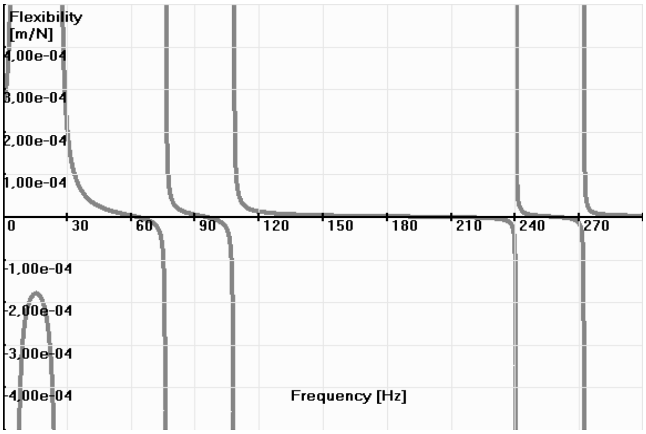

Fig. 2. Dynamical flexibility of the fixed beam system rotating with angular velocity equal 100 rad/s

In the figure 3 the dynamical flexibility of the fixed rod rotating with angular velocity equal 500 rad/s was presented.

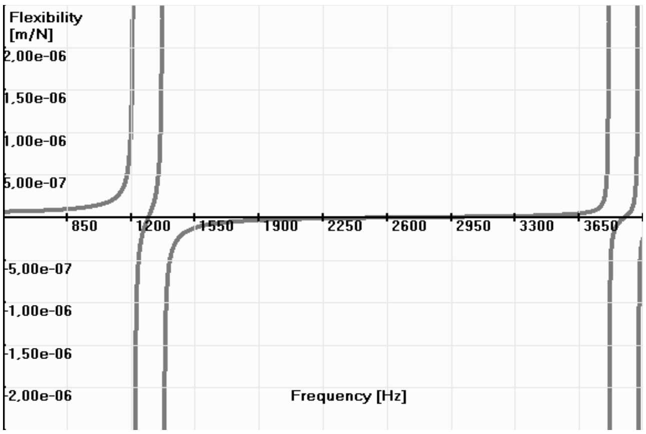

Fig. 3. Dynamical flexibility of the fixed rod system rotating with angular velocity equal 500 rad/s

In the figure 4 there was presented the dynamical flexibility of free-free beam rotating with angular velocity equal 500 rad/s, whereas in the figure 5 there was presented the dynamical flexibility of free-free rod system rotating with angular velocity equal 1500 rad/s.

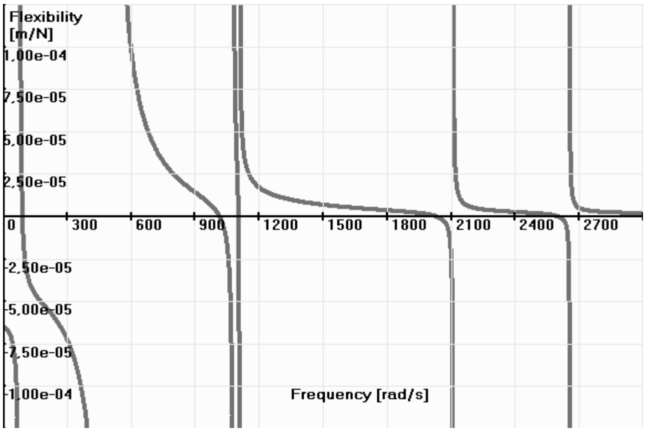

Fig. 4. Dynamical flexibility of the free-free beam system rotating with angular velocity equal 500 rad/s

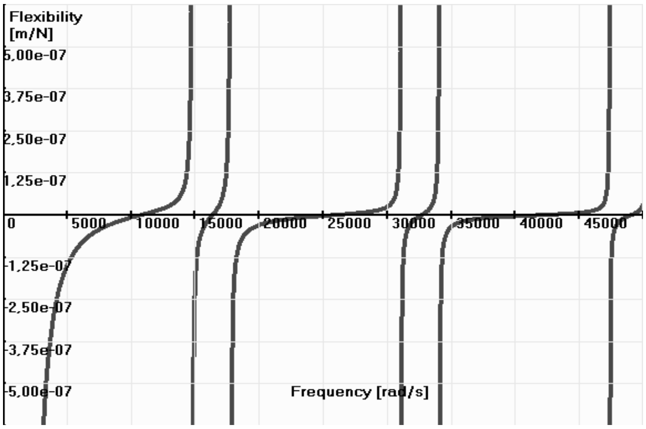

Fig. 5. Dynamical flexibility of the free-free rod system rotating with angular velocity equal 1500 rad/s

3.2. Forms of vibrations

In this subsection there were presented example forms of vibrations of analyzed systems generated in the Modyfit application.

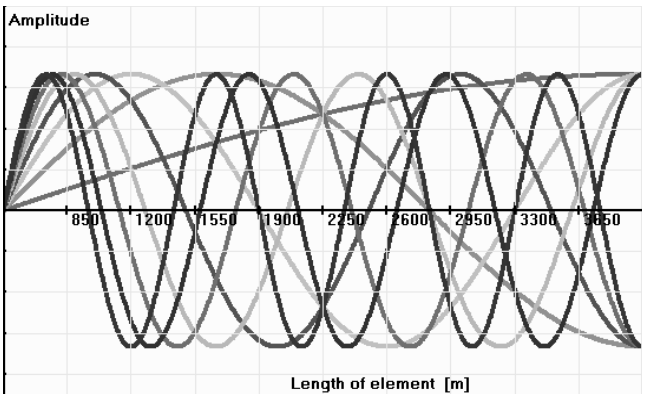

Fig. 6. Forms of vibrations of the fixed rod

In the figure 6 there was presented the chart of forms of vibrations of the fixed rod.

4. Conclusions

The numerical application MODYFIT was presented in this article. The name “Modyfit” is an abbreviation for **M**odelling **O**f the **DY**namic **F**lexibility **I**n **T**ransportation, where meaningful letters were bolded. This application is a numerical program where the mathematical model of vibrating systems in transportation was implemented. The program can be helpful in generating dynamical characteristics of rod and beam systems. In the application there is also possibility to analyze of complex systems, that can be interpreted as manipulators of robots systems.

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