1st International Congress of Serbian Society of Mechanics,
10-13th April, 2007, Kopaonik

DIAGNOSTIC OF THE DYNAMIC BEHAVIOR OF DRIVE UNIT

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Abstract: Dynamic behaviour of the drive unit was defined based on the dynamic calculation realized by finite element method. Frequencies and appropriate deformation fields (oscillations) were obtained by using program package KOMIPS. All structures of the considered construction of the drive unit were involved in calculation: gear-box (cover, input-shaft, middle-shaft and output-shaft), electromotor, coupling, performance shaft and momentum bar with the appropriate supports. Modelling was done by using plate (shell) and volume finite elements.

Key words: electromotor, gear-box, frequency, dynamic behaviour, finite element, drive unit

1. Introduction

In this paper dynamic behavior of Drive unit B-1800 – Kostolac (Figure 1) is presented. The power of electromotor [Sever – Subotica] is P=630 kW with angular velocity of n=980 o/min.

Figure 1. Drive unit B-1800 – Kostolac

Drive unit is consisted of three main parts: electromotor, gear-box and momentum bar with the appropriate supports.

2. Electromotor

The basic dimensions of electromotor, which model is presented on Figure 2, are 2375×920×1560 mm. Rotor-shaft is maden with changeable cross sections. Diameter of the shaft at the end with a coupling is ∅110 mm, at the middle lenght is ∅190 mm, and at the other end is ∅120 mm. The diameter of the coils of rotor is between ∅190 mm and ∅550 mm, and the coils of stator is up to ∅800 mm.

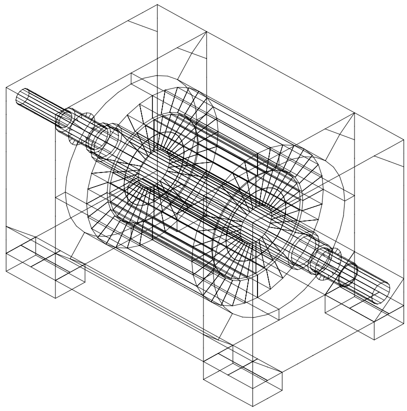


Figure 2. Model of electromotor (contour)

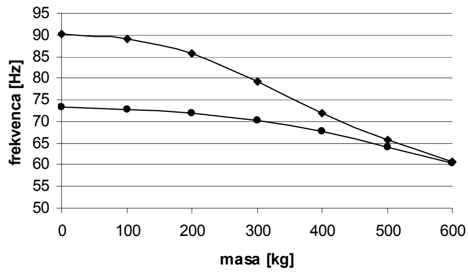


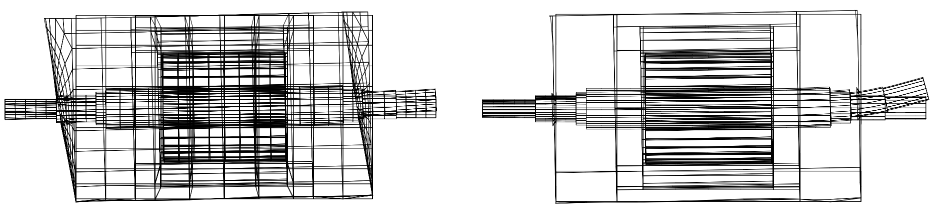
Figure 3. Eigen frequencies of electromotor as a function of coupling mass

At first, eigen frequencies and appropriate amplitudes of electromotor without the influence of coupling mass are obtained. Then, the calculation was done for the coupling masses from 100 kg to 600 kg. Obtained results are presented in Table 1 and on the diagram from Figure 3.

mass	0 kg	100 kg	200 kg	300 kg	400 kg	500 kg	600 kg
First frequency	73.3 Hz	72.8 Hz	71.8 Hz	70.3 Hz	67.7 Hz	64.1 Hz	60.3 Hz
Second frequency	90.3 Hz	89.1 Hz	85.8 Hz	79.2 Hz	71.8 Hz	65.7 Hz	60.8 Hz

Table 1. The influence of the coupling mass on the eigen-frequencies of electromotor

Second mode of oscillation of the construction of electromotor is presented in Figure 4 for the case without the influence of coupling and for the case with the coupling mass of 600 kg.



Coupling mass – 0 kg

Coupling mass –600 kg

Figure 4. Second mode of oscillation

Presented calculation is showing that the oscillation of the construction of electromotor is added up to the oscillation of the shaft. Amplitudes of sheet metal of the stator is less, especial in cases with a grate mass of the couple.

Eigen frequencies appropriate to bending in vertical level are higher then eigen frequencies appropriate to bending in horizontal level. With the increasing of coupling mass eigen frequencies are approaching, as we can see from the diagram from Figure 3.

Developed calculation is showing that the dynamic behaviour of electromotor is satisfied.

3. Gear-box

Considered gear-box is consisted of: cover, input-shaft, middle-shaft and output-shaft.

Cover of the gear-box is in dimensions 2550×1660×1060 mm. Lover part of the cover is shown in Figure 5. Figure 6 is presented input-shaft and middle-shaft.

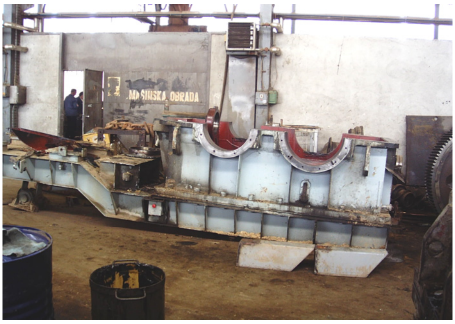


Figure 5. Lover part of the cover

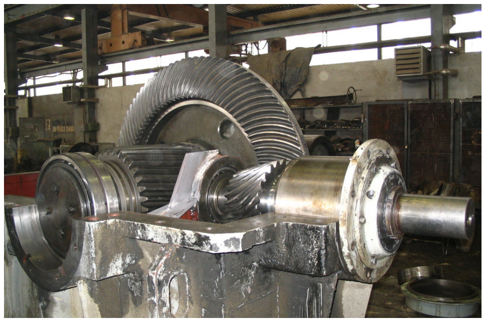


Figure 6. Input-shaft and middle-shaft

Model for finite element calculation is presented on Figure 7.

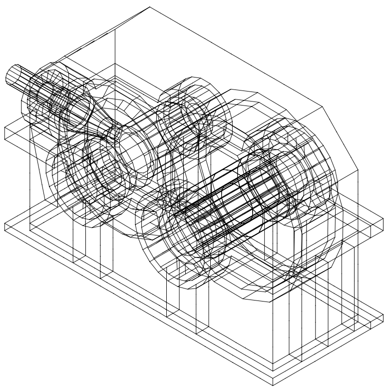


Figure 7. Model of the gear-box

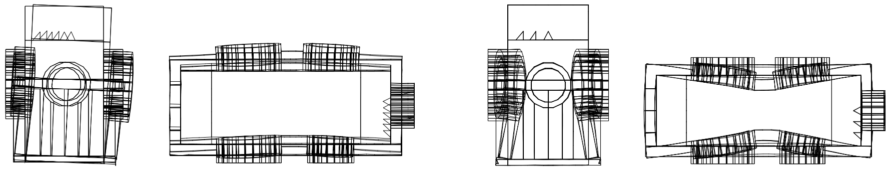
Input-shaft of the gear-box is 960 mm length, changeable cross-section. Diameters of the shaft on its ends are ∅150 mm and ∅120 mm.

Middle-shaft of the gear-box is 1100 mm length. Diameters of the shaft on its ends are ∅300 mm and ∅290 mm.

Output-shaft has length of 1050 mm and changeable cross-sections. Diameters of this shaft on its ends are ∅300 mm and ∅390 mm.

Modelling of the cover of gear-box is done using by 1886 nodes. Finite element mesh is formed with 937 plate finite elements and 335 volume finite elements.

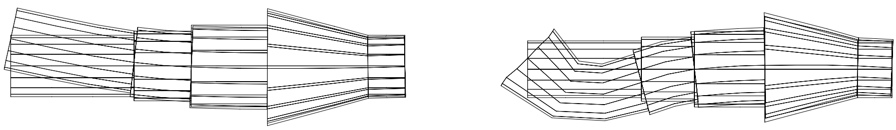
Obtained results are presented on Figure 8.



First mode Second mode

Figure 8. First and second mode of oscillations of the cover

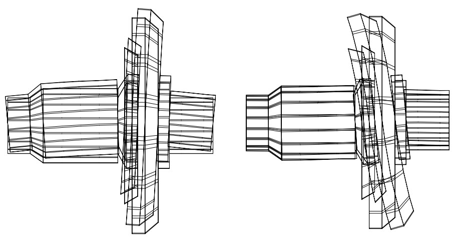
Modeling of the input-shaft of gear-box is done using by 766 nodes. Finite element mesh is formed with 576 volume finite elements. Dynamic calculation for this part of gear-box is done for two cases: withot the influence of the coupling and with the coupling mass of 500 kg.



First mode Second mode

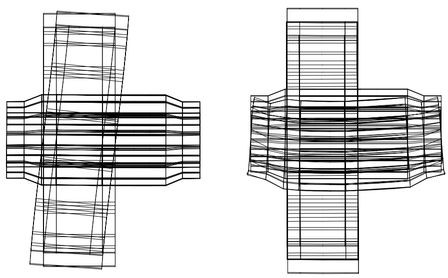
Figure 9. First and second mode of oscillations of the input-shift (coupling mass 500 kg)

Appropriate results for the middle-shaft and for the output-shaft are presented in Figures 10 and 11.



First mode Second mode

Figure 10. Amplitudes of middle-shaft



First mode Second mode

Figure 11. Amplitudes of output-shaft

The values of the appropriate eigen-frequencies [Hz] are noticed in Table 2.

Elements of gear-box :	Cover	Input-shaft		middle-shaft	output-shaft
		0 kg	500 kg		
First frequency	15.8 Hz	165 Hz	3.5 Hz	89 Hz	61.2 Hz
Second frequency	23.6 Hz	303.6 Hz	25.1 Hz	139 Hz	110.8 Hz

Table 2. Eigen frequences of the elements of gear-box

4. Drive unit

In next calculation, the construction of gear-box was coupled with electromotor and performance shaft, and placed on the momentum bar with the appropriate support as it is presented in Figure 12.

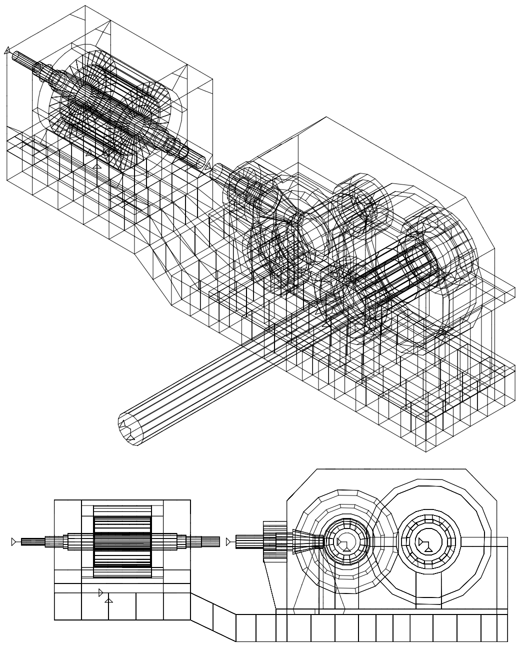


Figure 12. Drive unit

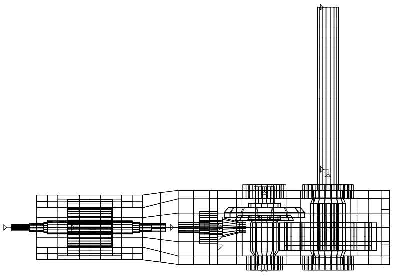
The calculation was done for three cases:

1. without the influence of the couple,
2. a part of a coupling mass on the shaft of electromotor is 80 kg, and a part on a input-shaft of gear-box is 400 kg,
3. a part of a coupling mass on the shaft of electromotor is 100 kg, and a part on an input-shaft of gear-box is 500 kg.

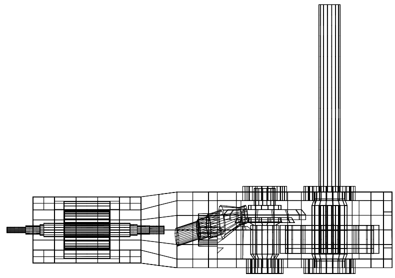
	1. [Hz]	2. [Hz]	3. [Hz]	4. [Hz]	5. [Hz]
First case	23.7	27.4	33.3	35.5	36.8
Second case	14.2	20.3	22	23.3	27.3
Third case	13.2	18.9	20.4	23.3	27.3

Table 3. Eigen-frequences of drive unit

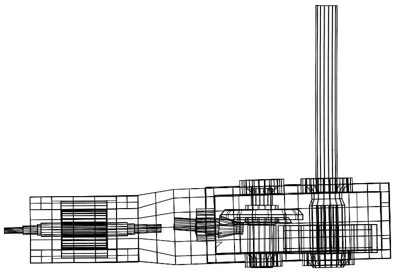
Results are presented on Figure 13 (amplitudes) and in Table 3 (values of eigen frequencies).



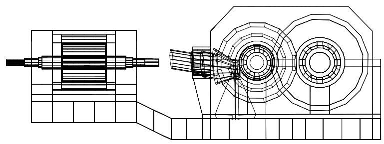
First mode



Second mode



Third mode



Forth mode

Figure 13. Amplitudes in first four modes

4. Conclusions

Presented calculation is shown that the eigen frequencies of all shafts of a gear-box are high enough. Dynamic behaviour of electromotor is satisfied, as well behaviour of the momentum bar. The problem is immanent only in the input-shaft of the gear-box because of the influence of coupling. This influence is dominant in first three modes.

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ANALYSIS OF STRESS-STRAINED STATE AT THE INTERFACE BETWEEN THE FUNCTIONALLY GRADED COATING AND THE ELASTIC HALF-SPACE CAUSED BY SPHERICAL INDENTATION

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Abstract:

Recent advances in technology have revealed numerous new methods of manufacturing functionally graded coatings and materials, but progress in this field is limited by the lack of knowledge about the mechanical behavior of such structures. Existing models of the mechanics of layered structures are not generally adequate for this purpose, since functionally graded structures can exhibit both qualitative and quantitative behavioral differences in comparison with homogeneous or layered structures, particularly if there is a significant gradient of elastic properties in the coating.

In applications, interest is focused mainly on the deformation fields and stresses inside the inhomogeneous material caused by the contact tractions. Stresses at the interface between the functionally graded coating and the elastic half-space are of particular interest because of their influence on the propagation of cracks and other defects on this interface.

In their work the authors' aim is:

- to develop a precise mathematical model and of the computational methods which makes it possible to achieve stable numerical results while analyzing the mechanical properties of functionally graded coatings;
- to study the variation effect in elastic properties on the maximum stresses in the surface layers of materials with functionally graded coatings caused by indentation.

Key words: functionally graded coatings, layered structures, inhomogeneous material, mathematical model, computational methods, indentation

1. Introduction

In the present paper the indentation problem for both layered and functionally graded half space is studied. We presume that the variation of the Lame coefficients with depth has general nature (arbitrary continuous or piecewise continuous functions of depth). We assume elastic properties of a half-space become stable with depth. In general, it may be represented as a inhomogeneous layer of thickness H, which is firmly coupled with a homogeneous half-space.