The use of information technology in the design of chippers for the production of technological chips

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Abstract. Currently, there is an acute problem of reducing the harmful effects of humans on the environment, the introduction of resource-saving technologies that allow the maximum use of natural raw materials with a minimum percentage of waste. In the production of products at wood working and sawmill enterprises, a large amount of wood waste is generated that requires either disposal or use for the production of wood chips and shavings used in the production of chipboard, OSB boards, fuel briquettes and pellets. Processing of wood waste is carried out in various chippers of a stationary and mobile type, while it must be taken into account that a large amount of wood waste is generated in cutting areas, lower warehouses of enterprises, therefore, mobile chippers must be used for their processing. Given that the diameter of the chipping disc can exceed 1000 mm at a speed of up to 1500 rpm, during the operation of the chipper, significant loads on the working tool and vibration occur, which can lead to its failure. Vibration during the operation of the chipper can be the result of both design errors and occur when the cutting knives are blunt.

1 Introduction

In the production of woodworking and sawmill products, secondary raw materials and waste are generated. Their uses are not equal. Part of the waste is used for further production of products, the other part is recycled. It should be taken into account that production wastes appear in the cutting area (in the form of branches, tops), when debarking logs (bark), cutting into lumber (slab, lath), in the production of wood products (lump waste, shavings). The resulting waste requires their disposal, however, often, it consists in storage at landfills or subsequent incineration, which is harmful to the environment, because. wood waste is a breeding ground for harmful insects and has a high degree of fire hazard. At the same time,

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wood waste can be a good raw material for further use in the production of various products, such as particle boards, OSB boards, fuel briquettes, pellets, and so on.

To improve the efficiency of wood resource use, an integrated approach to wood processing is required at each stage of production: wood harvesting, primary sawing, and the production of finished products.

Currently, the main trend in all areas of human activity is the widest possible digitalization, including in the field of design, production, operation of machines for various purposes and industries [1,2]. Information technologies are applied at the following stages:

- search for information about similar equipment at the stage of marketing analysis [3];
- machine design design using specialized CAD systems such as Autodesk Revit and Autodesk 3DS Max [4];
- calculation of the created models, for example, using the finite element analysis method [5];
- automation of the design process and calculation of the machine dynamics [6];
- conducting virtual tests of machines to achieve high performance indicators [7];
- development of technical processes and control programs for the manufacture of parts on CNC machines [8];
- monitoring the state of the machine during its operation [9];
- management of maintenance and repair of the machine [10, 11, 12].

Today, both Russian and foreign manufacturers offer a wide range of chippers for processing round and split timber, low-quality wood, sawmill and woodworking waste, logging waste and wood scrap into chips.

Chippers, like a number of other woodworking machines [13, 14], experience serious dynamic loads during operation, an increased level of vibration, which must be taken into account both when designing machines and during operation.

2 Materials and methods

Chippers are characterized by a high frequency of rotation of the knife disk, which leads to increased vibration. During the operation of the chipper, dynamic loads increase both when the material supply is too large and when the knives become dull, while the knife operation time depends on many factors, such as wood species, humidity, ambient temperature, abrasive contamination of wood, which intensifies the wear of the cutting edge. edges, both due to gradual wear and brittle fracture [15]. Knives blunting control can be monitored periodically (for this it is necessary to stop work and take measurements) or to diagnose the blunting of knives by exceeding the permissible value of vibration that occurs when cutting with a blunt knife, for example, by installing vibration sensors on the machine body [16], which allow diagnosing blunting of knives in real time by connecting it to the machine monitoring system.

The dynamic loads that occur during the operation of the chipper are not only the result of cutting conditions, material feed, blade blunting, but, first of all, the quality of the machine design. When designing a chipper, it is important to exclude the possible resonance of the chipper shaft; for this, appropriate calculations should be carried out, performed in specialized CAD systems based on the construction of a 3D model in a CAD system.

Calculation of natural frequencies and shape of oscillations of a shaft with a cutting disk can be carried out in MathCad [17], APM Winmachine [18] or other software products.

3 Results and discussion

The calculation is carried out in the following sequence:

- technological calculation of the chipper with the determination of the forces that arise when cutting wood;
- design calculation of the shaft of the chipping disk;
- checking calculation of the shaft of the chipping disk;
- dynamic calculation of the chipper shaft.

Technological calculation is carried out according to the standard method, to automate calculations, you can use a software product for performing calculations, for example, MathCad [17], while determining:

- length and thickness of chips;
- cutting force;
- cutting power;
- cutting work.

The design calculation of the shaft begins with the construction in the CAD system of the design scheme of the shaft with a chipping disk (Figure 1).

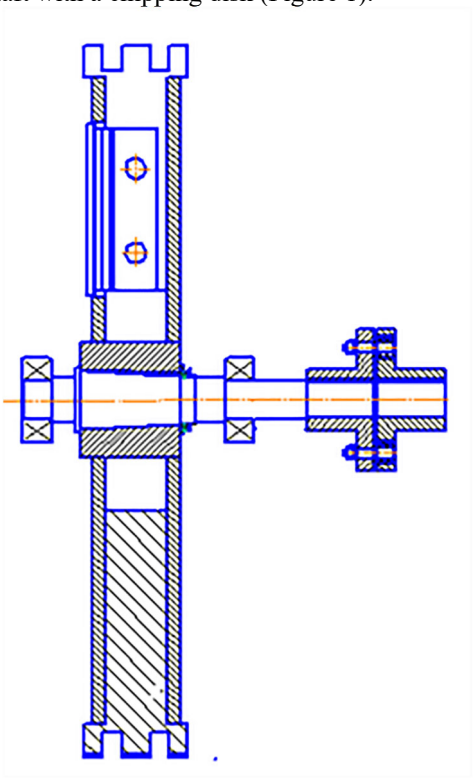

Fig. 1. Calculation scheme of the shaft.

The initial data for calculating the shaft are the geometric dimensions of the designed machine.

Defined:

- moment of inertia of the disk;
- torque;
- plots are built (Figure 2);
- support reactions;

– equivalent moments;
– shaft segment diameters.

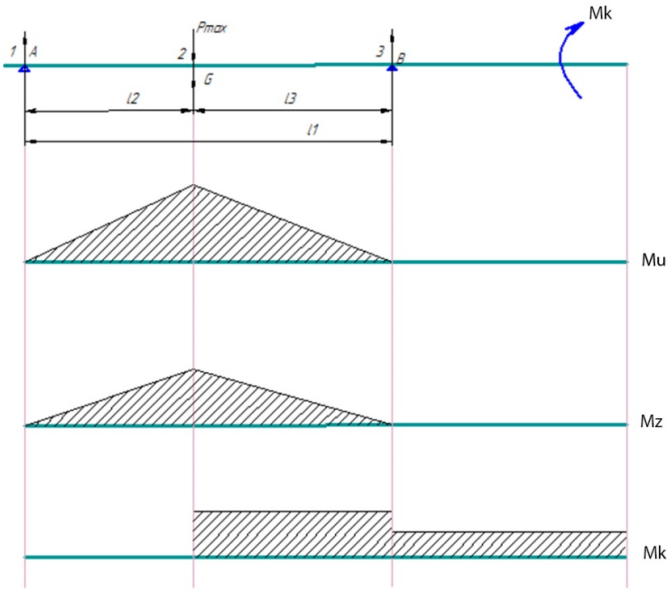

Fig. 2. Diagram of diagrams for calculating the shaft.

The check calculation of the shaft of the chipping disk is carried out on the basis of the condition that the normal stress changes in a symmetrical manner, and the tangents in a normal cycle. The dangerous section is under the disk.

Defined:

– calculated value of the coefficient of endurance;
– stress in the shaft section;
– overall safety factor for resistance to plastic deformation.

To ensure the high dynamic quality of the machine, it is necessary to calculate the natural frequencies and vibration modes of the chipping disk shaft to prevent their coincidence during operation and the occurrence of resonance that can lead to the failure of the chipping disk.

To calculate this calculation, it is necessary to use specialized CAD systems, for example, APM Shaft (included in the APM Winmachine software package), in which a shaft is built, acting loads, moments of forces and inertia are applied (Figure 3).

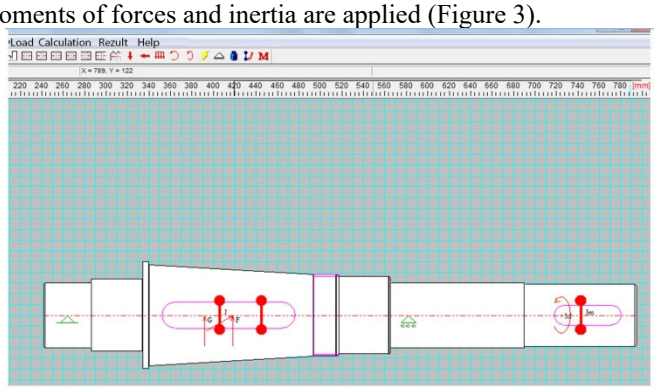

Fig. 3. Shaft drawing with loads acting on it.

As a result of the dynamic calculation of the shaft, the natural bending and torsional vibrations of the shaft and their shapes are calculated (Figures 4-5).

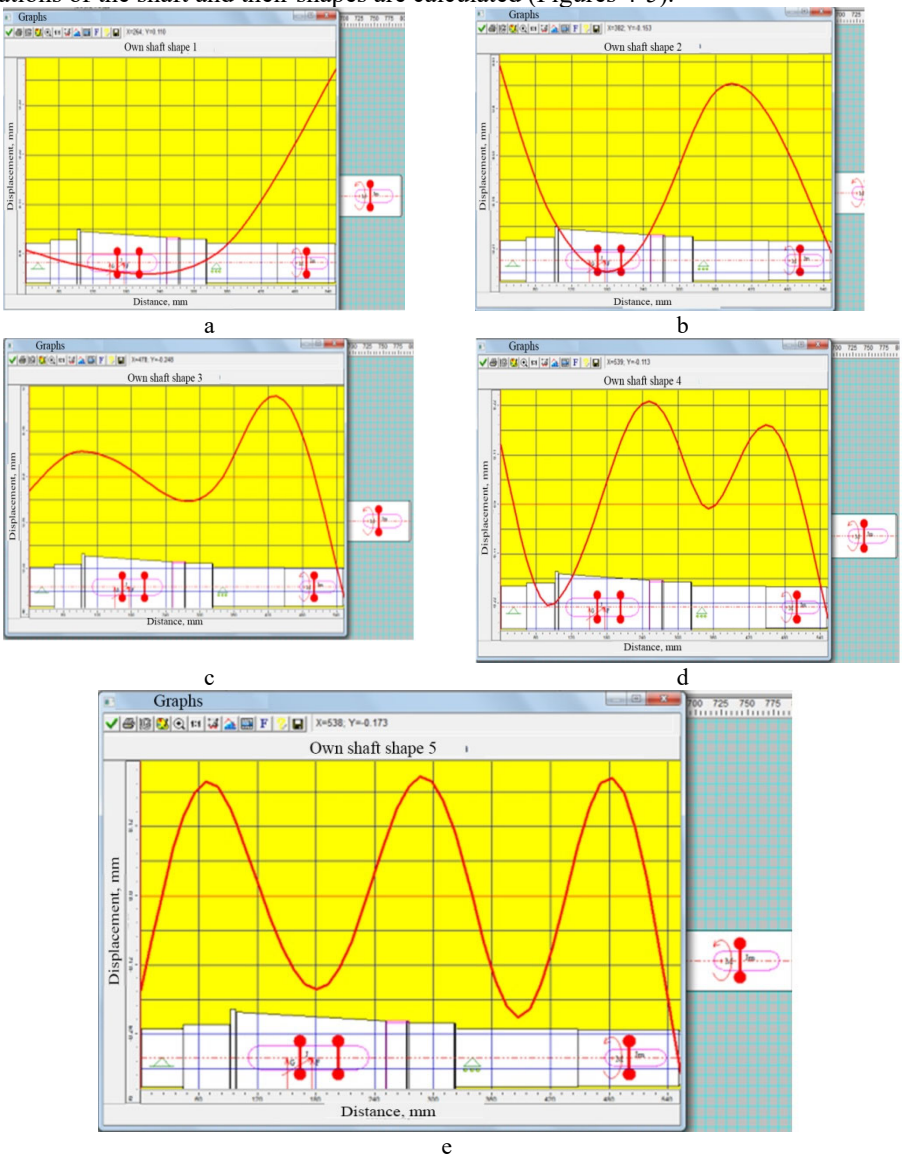

Fig. 4. Form of bending vibrations: a – at the first natural frequency; b – at the second natural frequency; c – at the third natural frequency; d – at the fourth natural frequency; e – at the fifth natural frequency.

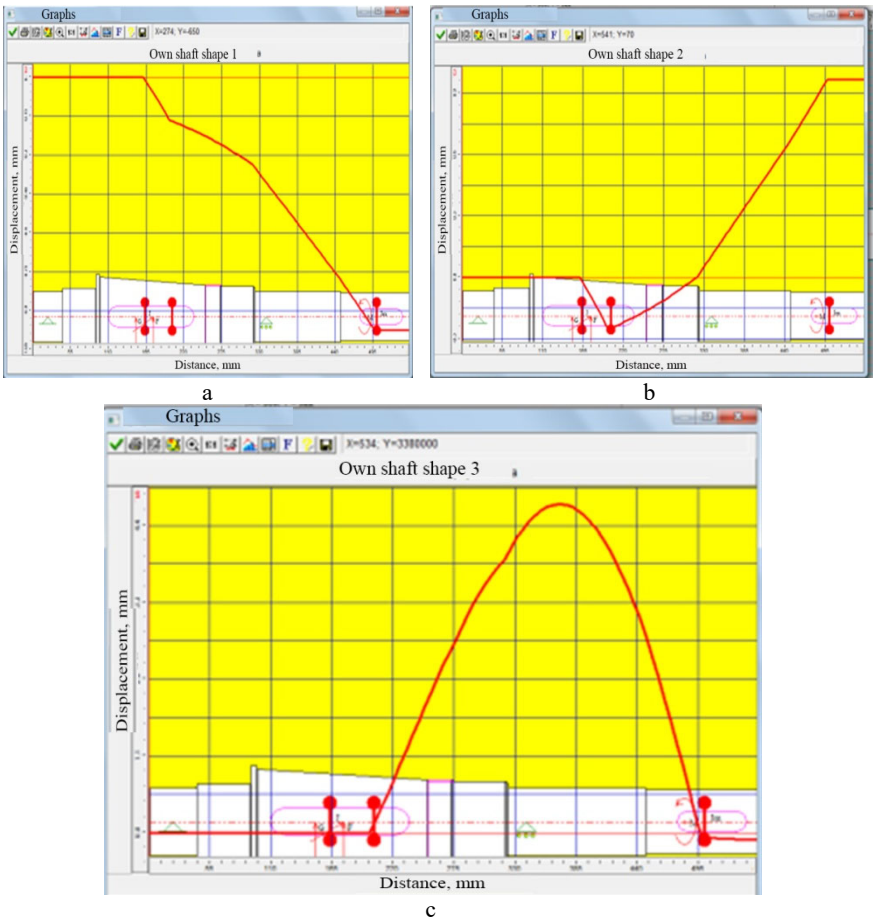

Fig. 5. The form of torsional vibrations: a – at the first natural frequency; b – at the second natural frequency; c – at the third natural frequency.

Based on the results of dynamic analysis, it is possible to analyze the design, while, if necessary, adjustments are made to the design and re-checked, achieving acceptable results.

4 Conclusion

Digitalization of all activities ensures the achievement of a new quality of products, control of their technical condition and management of maintenance and repair. The use of information technologies, both in the design and operation of chippers, will ensure the high quality of the resulting chips, low vibration, control the degree of blunting of cutting knives, and hence increase the efficiency of the chipper.

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