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ACCELERATED MODELING OF CIRCULAR SHAFT IN CAD ENVIRONMENT

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Abstract:
An approach for accelerated generating of a circular shaft 2D model with AutoCAD Mechanical® is presented. The 2D model of a smooth shaft (shaft without keyslots, grooves for spring clip, center holes, thread for fixing of mounting flanges, etc.) is created.
Computer simulation of the circular shaft loading is performed. The resultant values of the bending moment, deflection, bending stress, von Misses Stress, torsion stress are computing and graphically presented. The factors of safety guarding against fatigue failure and against yield point are also calculated.
Key words:
circular shaft, load, stress, factor of safety, AutoCAD Mechanical

1. INTRODUCTION

In the last years the methods of automation of the products designing are widely applied in the practice. The direction of present interest in this field is the work with computer geometrical models. This allows a possibility for repeatedly optimization of the product geometry in the earliest stages of designing and contributed for increasing of the products quality.

The task of the present investigations is to propose an approach for accelerated generating of a circular shaft 2D model and computation of static strength with AutoCAD Mechanical®.

2. AN APPROACH FOR ACCLERATED MODELING OF CIRCULAR SHAFT

The accelerated approach for generating of the circular shaft model is expressed in generating of 2D model of a smooth shaft with AutoCAD Mechanical® [1].

The model is generated according to prior calculated circular shaft with a single circular disk with diameter 180 mm designed for undercutting of chipboards with folio and plastic coating. The mechanism is driven by an electric motor (power - 1,5 kW and revolutions - n_1=2860 min^{-1}) through a V-belt transmission with a gear ratio i=1,15 and it is operating in two working shifts at average loading.

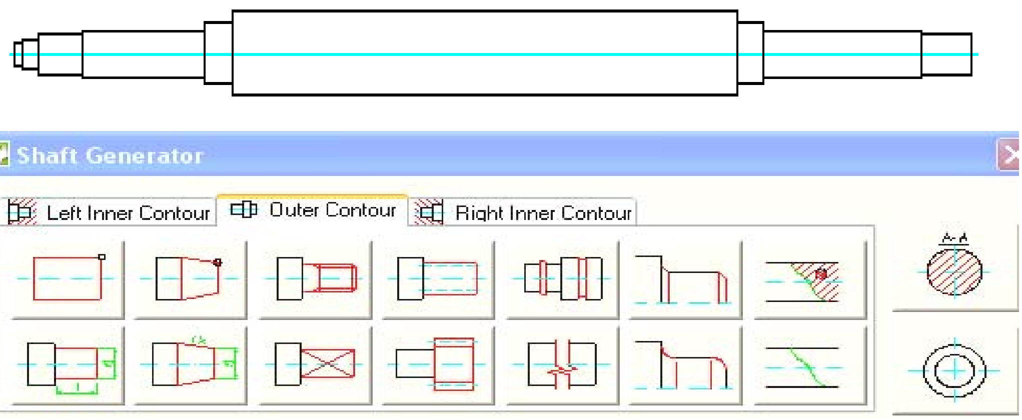

Figure 1. 2D model of a circular shaft

The 2D model of a smooth circular shaft – shaft without keyslots, grooves for spring clip, center holes, thread for fixing of mounting flanges, etc. is generated – Fig 1. 2D shaft model is created with the help of the module “Shaft Generator” [1]. The kind (cylindrical, conic), the length and the diameter of the shaft shoulders are consecutively set.

3. COMPUTER SIMULATION OF THE CIRCULAR SHAFT LOADING

The following loads and moments are acted on the circular shafts – torsion moment, total cutting force, including the feeding force, circular disk and flanges weight and stretching force [2-4].

In comparison with another CAD products, for example SolidWorks [5, 6], AutoCAD Mechanical® offers simulation of the loading respectively of deformation and stress calculations only of shaft 2D contour model.

The following moments and forces are applied to the shaft according to scheme shown in Fig.2: torsion moment M_{t2} = 5,59 N.m, cutting force F =60 N (under angle $\delta_2=28^o$ to the horizontal), force due to belts stretching Fr=630 N (under angle $\delta_1=60^o$ to the horizontal and it is directed to the intercenter line of the pulley). The two forces are decomposed by two components each, which are acted in interperpendicular planes: horizontal *xy* and vertical *xz* – Fig.2 [2-4].

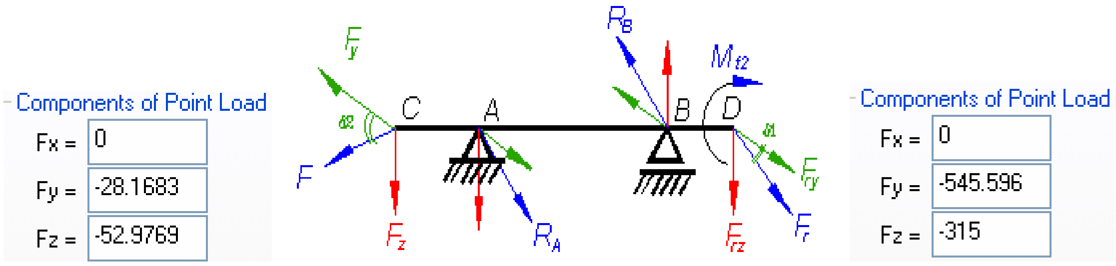

Figure 2. Scheme of loading and load components

The loading simulation of the shaft is performed with the help of the module “Shaft Calculator” of AutoCAD Mechanical® – Fig.3.

The first step is to select of the shaft material. As the shaft is working at average loading, it is manufactured from plain carbon steel ASt5 BDS 2592:1971. GS-45 DIN 1681 steel was chosen from the material library of AutoCAD Mechanical® with properties most closely to the noted bulgarian steel: tensile strength 450 MN/m²; yield point 230 MN/m²; E-module 2,1.10¹¹ N/m², Poisson coefficient 0,3.

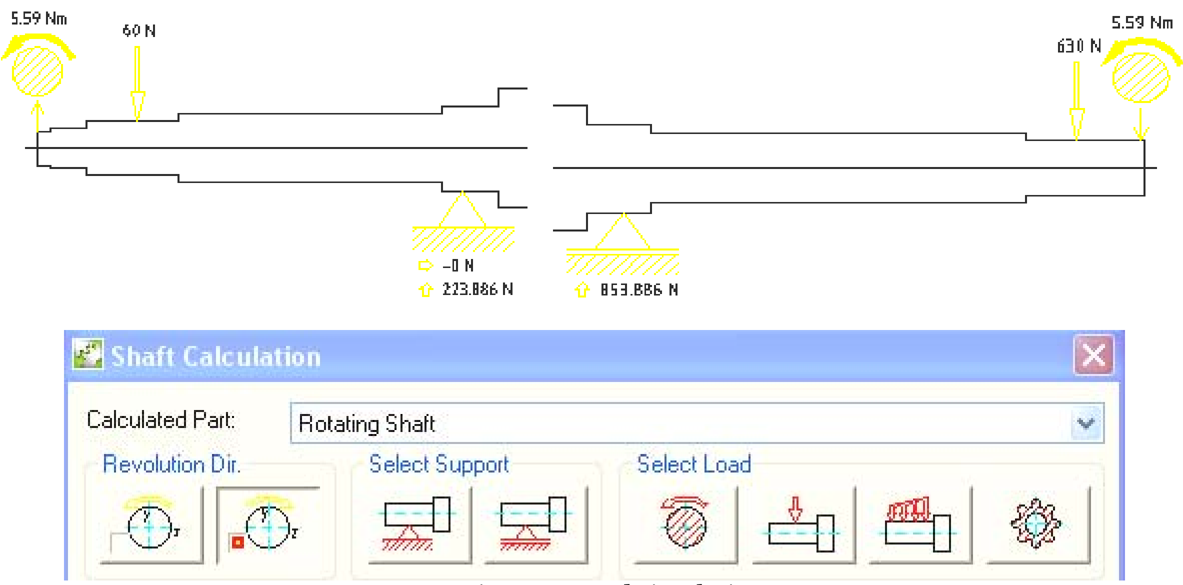

Figure 3. Load simulation

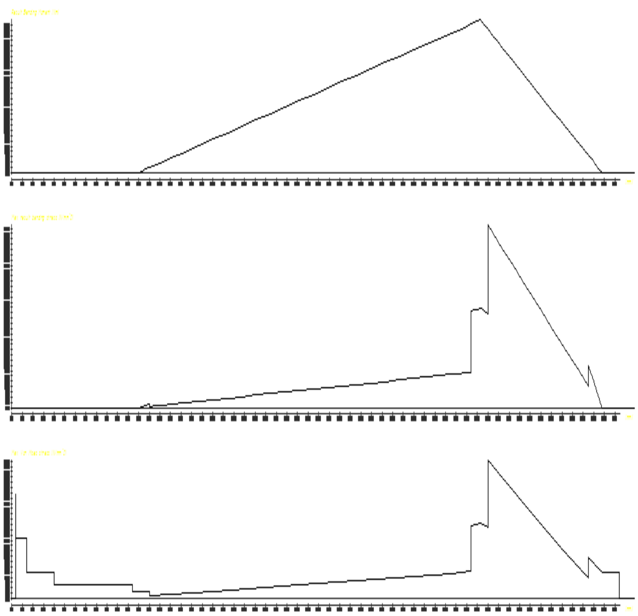

Figure 4. Bending moment, bending stress and von Misses stress

After that the revolution direction is set and supports are defined – Fig.3. The torsion moment at shaft journal, where pulley is assembled is set. After that the resultant forces and the forces angles are applied. The module calculates the force components and reaction forces, shown in Fig.3.

The resultant values of the bending moment, deflection, bending stress, von Misses Stress, torsion stress are computing. The distribution of the bending moment, bending stress and von Misses Stress as a function of shaft length is graphically presented in Fig4.

The maximum resultant values of the deflection, bending moment, bending stress, von Misses Stress and torsion stress are pointed in Table 1. The x coordinates (shaft length), at which the maximum values of the cited characteristics were calculated, are also pointed in Table1.

Table 1. Maximum resultant values of the characteristics

Characteristic name	Calculated Value	Coordinate x, mm
Max Resultant Deflection	336,1.E-03 mm	588,168
Max. Res. Bending Moment	72,345 N.m	443,014
Max. Res. Torsion Stress	28,469 N/mm²	3,968
Max. Res. Bending Stress	86,507 N.m	450,0
Max von Mises Stress	65,43 N/mm²	450,0

Strength calculations in specific points of the shaft are performed for right support – the factors of safety guarding against fatigue failure and against yield point are also calculated: factors of safety of 3,983 for fatigue failure and 5,857 for yielding point.

4. CONCLUSIONS

An approach for accelerated modeling of a circular shaft with AutoCAD Mechanical® is presented. This approach allows to perform very quickly verifying deformation and stress calculations of the shaft 2D contour model and to make corrections in the model if necessary.

The maximum resultant deflection, bending moment, bending stress and von Misses stress are calculated at right end of the shaft, that the pulley is mounted.

Strength calculations are performed – the factors of safety guarding against fatigue failure and against yield point are more than 1, that shows no danger of failure exist. The shaft is correct preliminary calculated and will bear the loading set. No corrections in the model are necessary.

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