FINITE ELEMENT ANALYSIS OF CONVEYOR BELT DRUM

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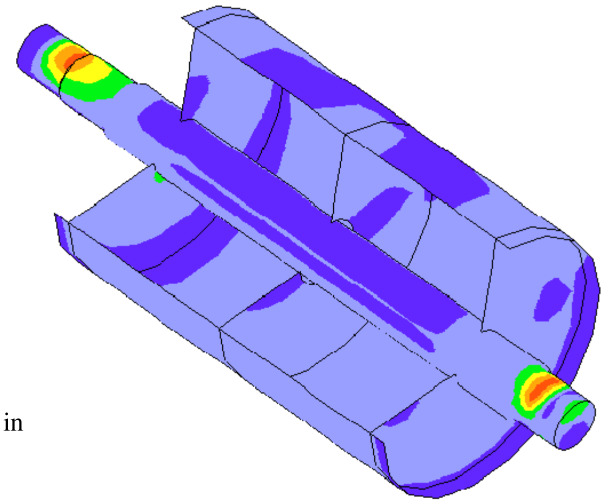


This paper presents the results obtained by **PCE Ltda.** in a finite element analysis of motive drums for bowls accomplished for Tecnomoageira Ltda. The calculations were executed considering the critical loading that they will be submitted and the physical properties of the materials used. The finite element analysis, linear static stress and deformations were executed using the ***Algor Inc.*** *(www.algor.com)* finite element software.

The Model

Two drums were modeled whose basic dimensions are in Table 1 and Figure 2.

Table 1. Principal dimensions

	Drums dimensions (mm)	
	800x1200	800x1600
D	800	800
B	1200	1600
S	9,5	7,7

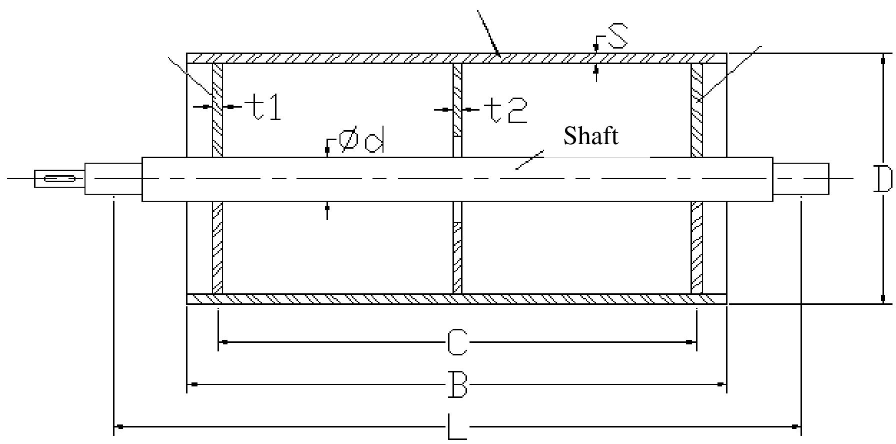


Table 2. Materials

Part	Material	Yield stress (MPa)	Rupture stress (MPa)	Modulus of elasticity (MPa)	Poisson's ratio
Shaft	AISI 1020	210	320	210.000	0,3
Drum	ASTM A36	353	490	200.000	0,29

Owed the contour conditions that the drums are submitted it was necessary the generation of a three-dimensional model (3D) for the analysis by finite element.

To model the shaft we used the element **Type 5 ("Brick")** with 6 or 8 knots, 3 degrees of freedom for knot. For the plates of the drum we used the element **Type 6 ("Plate")** with 4 knots, 6 degrees of freedom for knot.

The 800x1200 model is composed by 672 solid elements and 882 plate elements. The 800x1600 model has 672 solid elements and 828 plate elements. A cutaway view of the 800x1200 model is shown in Fig. 3.

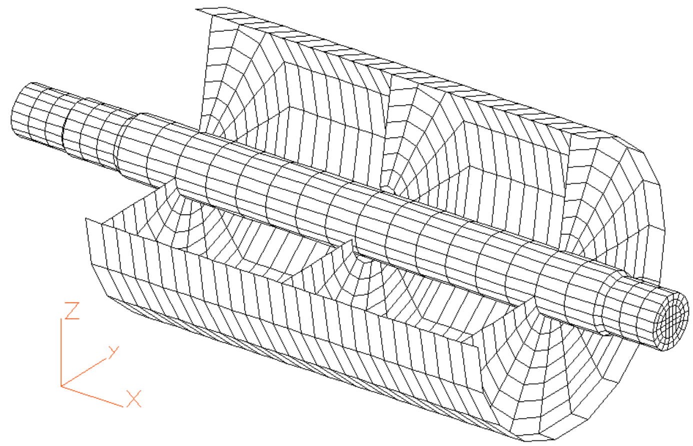
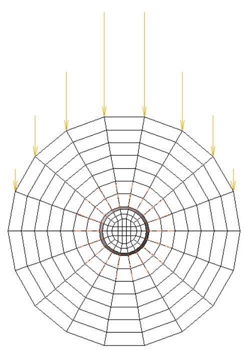
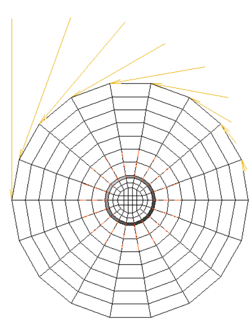


Figura 3. Cutaway view of the model

Table 3. Loading

Vertical Loading	
 *Figure 4. Vertical loading distribution.*	Corresponds the sum of the total load of the bowl, 10% due to the screws and nuts, weight of the belt, own weight of the drum and resultant force due to the traction of the belt. Those forces are responsible for the drums bending.
Moment	
 *Figure 5. Moment distribution*	Corresponds the moment due to the driving of the drum by the motor. This loading just exists in motive drums and is applied through forces acting tangentially to the drum.

Optimization

The critical area in the drums is the lateral disks, mainly the disks of the extremity of the joining (main disk) where the moment is applied. The other lateral disk is called secondary.

In this optimization it is made an analysis of the two models behavior used by the thickness variation of the two lateral disks.

Flexible Lateral Disks versus Rigid ones

With the results obtained by finite element we generate a graph, according to Figure 6, relating the thickness of the models lateral disks with the maximum stress in the main lateral disk.

The two minima of the curves indicate the values of thickness for which we obtain the smallest stress values. High values of thickness don't necessarily indicate a low level of stress, in opposite, it can be obtained even larger values of stress (intermediate area of the curve among the two minima).

For the minimum of the curve obtained with smaller thickness we have a project of **flexible lateral disk** - where the moment of flexure transmitted by the drum is minimum. For the other minimum of the curve (higher values of thickness) the project is of **rigid lateral disk** - where almost all the moment of flexure is transmitted by the drum and the stresses stays low due to the robust dimensioning of the lateral disk.

In the case of the 800x1200 drum, dimensioning it as rigid (t1 = 3 ") we will have a weight of 1374 kg, and dimensioning it as flexible (t1 = 3/4 ") the weight is reduced to 759,6 kg - a reduction of 45%.

In the case of the 800x1600 drum, dimensioning it as rigid (t1 = 3”) we will have a weight of 1742,2 kg, and dimensioning it as flexible (t1 = 3/4”) the weight is reduced to 1121,0 kg – a reduction of 36%.

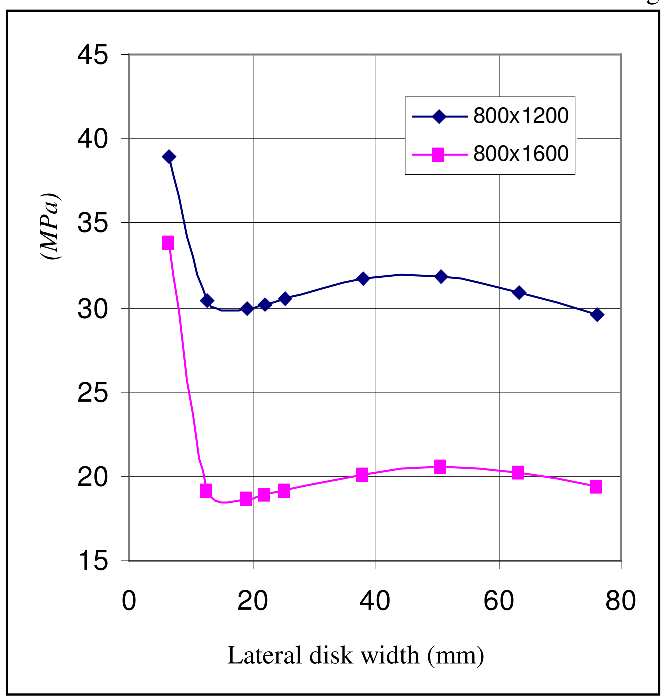


Figure 6.Maximum stress for different widths

Fatigue

For the fatigue analysis of the drum we used the program Fatigraph® who generated the Smith-Goodman diagram for the axis and the Haigh diagram for the plates. In this diagram the amplitudes of the maximum and minimum principal stress are plotted. The fatigue analysis of the axis revealed (see graph in Figure 7), that the maximum points plotted are below the line it limits for fatigue failure, therefore, well dimensioned to this criteria.

In the fatigue analysis of the plates a reducer of acceptable stress was used to consider the imperfections about the welds, therefore the maximum stresses happen close to it. The analysis revealed (see graph in Fig. 8) that the maximum points plotted are below the line it limits for fatigue failure for welded components.

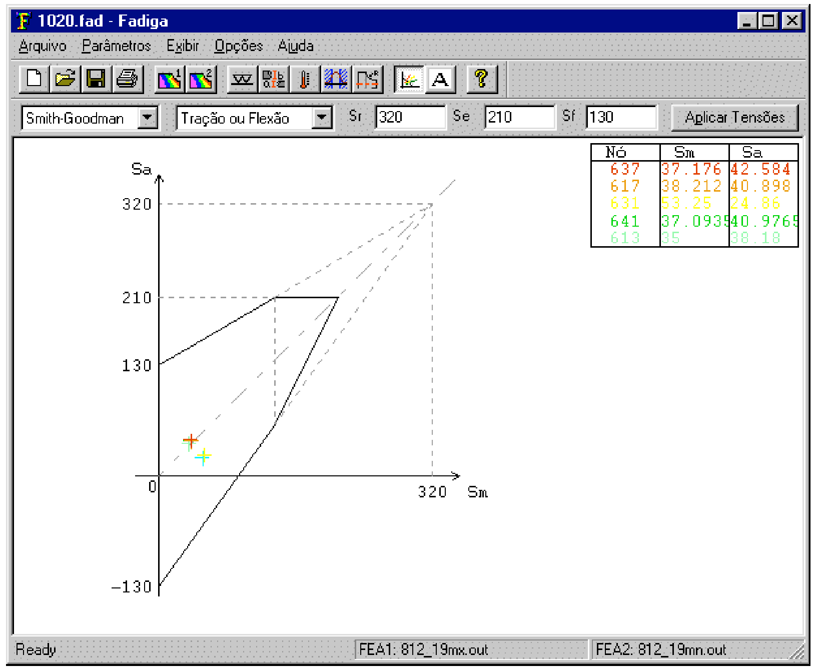


Figure 7. Smith-Goodman fatigue diagram for the axle - AISI 1020

Conclusion

Finite element, using Algor Inc.'s software, demonstrated to be an important tool in the analysis of drums for transporters. So, it we can project a drum as being flexible, what reduces the weight of the same considerably. It is evident in this paper the advantage of a flexible lateral disk in front to a rigid one.

The software Fatigraph by PCE improves the work of the fatigue analysis of the drums, because it reads the results directly generated by the finite element analysis.

This analysis procedure increases the calculation reliability, allowing to the designer to reduce "unknown" factors, which in most cases take to the oversizing of the project.

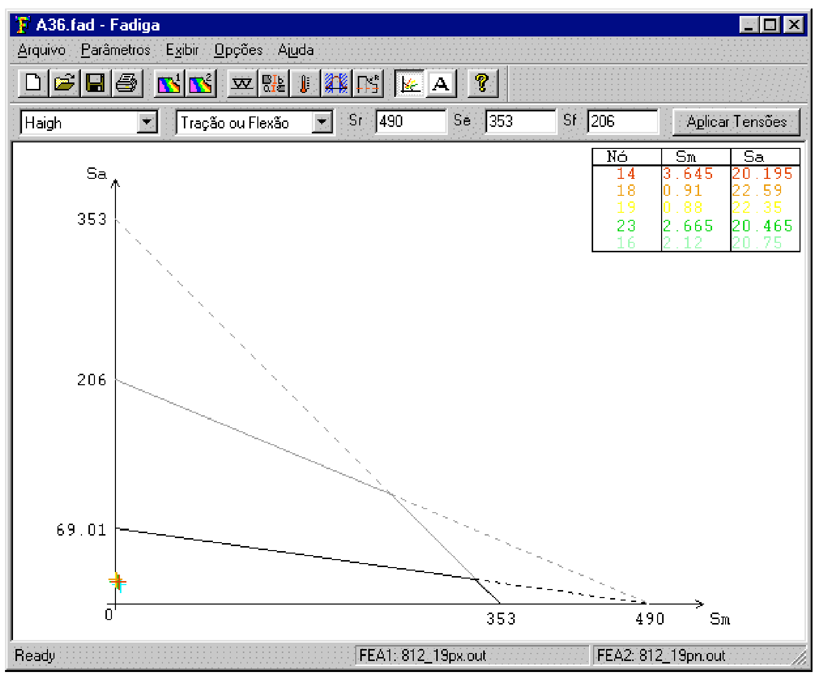


Figure 8. Haigh fatigue diagram for the plates - ASTM A36

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