passenger lift, CAD, designing, disk springs

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USING DISK SPRING SOLVER APPLICATION FOR PROTOTYPING DISK SPRINGS IN PASSENGER LIFT CATCHERS

Abstract

The foregoing study presents the use of Disk Spring Solver DSS application for prototyping configurations of disk spring pile applied in the design of friction lift catchers. The methodology of disk springs selection was presented on the basis of possibilities given by DSS application. On the basis of this application and the conducted analyses disk springs were optimally matched with catchers as main flexible element. The design of catchers was worked out in model environment SolidWORKS 2012 together with MES analysis.

1. INTRODUCTION

Nowadays virtual prototyping is a very convenient tool, not much increasing the costs of manufacturing new products. With the application of the newest tools from the domain of rendering the product can be very realistically visualized, with emphasizing of its aesthetic values. On the basis of the created 3D documentation structural changes can be made quickly, as well as rendering and preparing offers for customers. To obtain full computer support, except the above-mentioned advantages of 3D systems, there are still other programs by means of which our work can be easily and quickly supported, especially in technical domains.

In the foregoing study we showed the use of SPRING DISK SOLVER application for selecting disk springs applied in constructing catchers which have been worked out in SolidWORKS 2012 environment. Literature contains many examples of supporting engineering works with computer applications [1, 2, 4, 5, 6, 7].

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2. EMERGENCY CATCHER BRAKING

Figure 1 shows the project of a new solution for catchers which are to be manufactured as first in Poland. Catchers are nothing else but brakes, the tasks of which is to arrest the moving car of passenger lift. Catchers are to arrest accelerated lift car burdened with nominal load in the case of exceeding the speed by 0,3 m/s in relation to nominal speed. The increase of the moving car speed can be in fact caused by two cases [8, 10]:

- by breaking carrying springs,
- by sudden acceleration of driving system.

In actual working conditions of lift appliances none of these cases occurred.

3. DESIGN OF CATCHERS

Figures 1 and 2 show the virtual prototype of catchers worked out in SOLIDWorks 2012 environment. Catchers belong to the group of subassemblies with percussive working conditions. This means that all the elements of catchers during braking undergo overloading caused by losing energy of accelerated car weight.

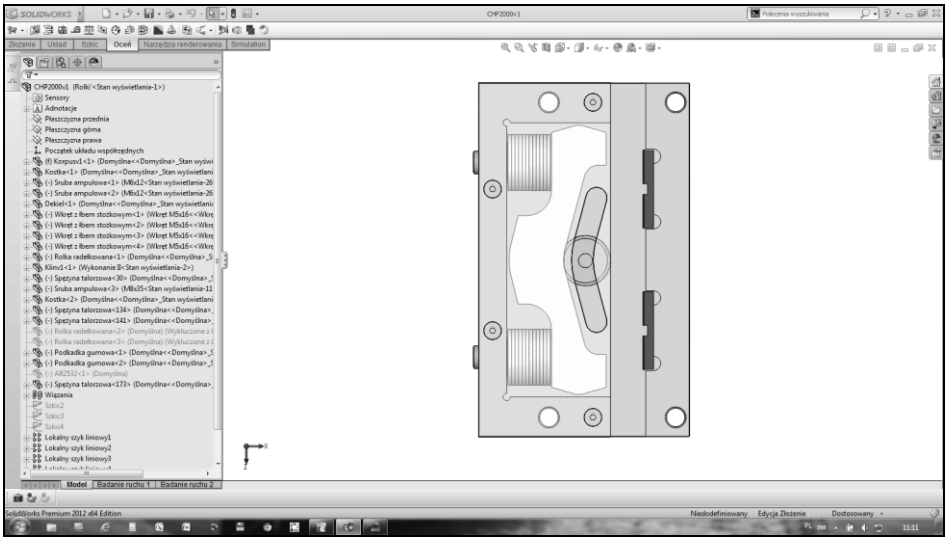

Fig. 1. Virtual design of catchers worked out in the environment SolidWORKS 2012 with a braking roll placed in neutral position [source: own study]

Figure 2 shows a catcher with a braking roll placed in the position where the roll contacts the guide after it is stopped. In other words, the presented figure shows the maximum position of braking roll in the catcher body.

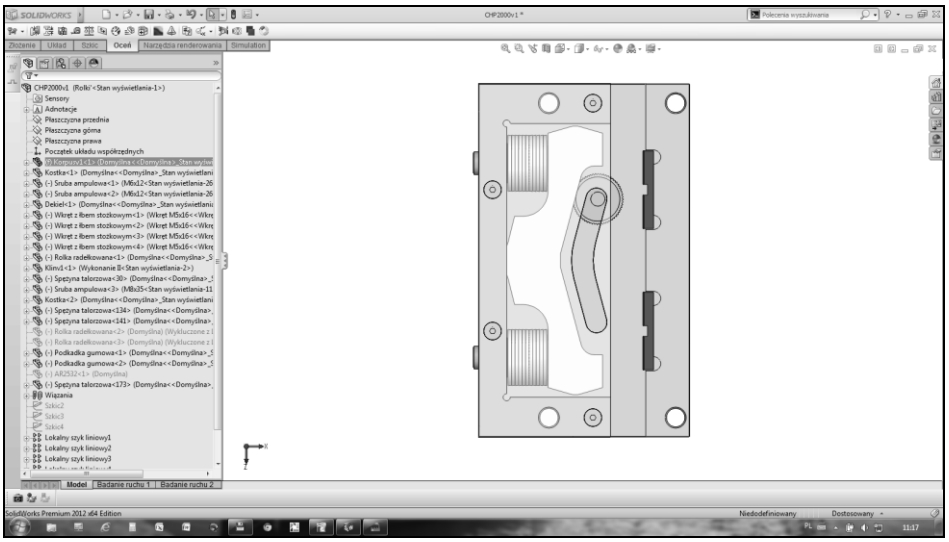

Fig. 2. Virtual design of catchers worked out in SolidWORKS 2012 environment with braking roll in the position of maximum deflection from neutral position [source: own study]

On the basis of survey of the available literature [3, 8, 9] and the solutions available in the market, we suggested a solution of catchers shown in figure 1 below 1.

An innovative approach to the presented catcher structure is that during braking, the force generated by the package of disk spring is variable in relation to the braking distance made and that the braking force changes with the change of roll position in relation to cam. The above means that the trace left on the guide after braking is of variable depth, and that braking depth depends upon the value of braked weight. Such an approach is aimed at soothing braking with simultaneous securing the highest comfort of the passengers.

Having performed the CAD project validation by means of MES software, we eliminated all the unfavorable places in the body and roll, thus obtaining the optimum shape of catcher structure.

To secure the appropriate catcher work, the methodology of selecting disk spring package, in result of which changes can be made easily and quickly in the spring pile configuration arrangement in the catcher.

To optimize the selection of spring packages the available application named SPRING DISK SOLVER was used.

4. SPRING DISK SOLVER – DECISION SUPPORTING TOOL

The available application for selecting disk springs is based on the base of disk springs available in the market. Selecting an appropriate spring pile the user is able to lie the characteristics of the load of single spring and the required package on the basis of input data.

Figure 3 shows the main window of the program where in field I (Pole I) we enter the dimensions of spring we are interested in, in field II (Pole II) we determine the pile of springs, in field III (Pole III) we calculate loads and stresses of strings used in the configuration (pile), and in field IV (Pole IV) we lie the characteristics of springs, on the basis of which we can check at which deflection the required load of the matched spring package will take place [11].

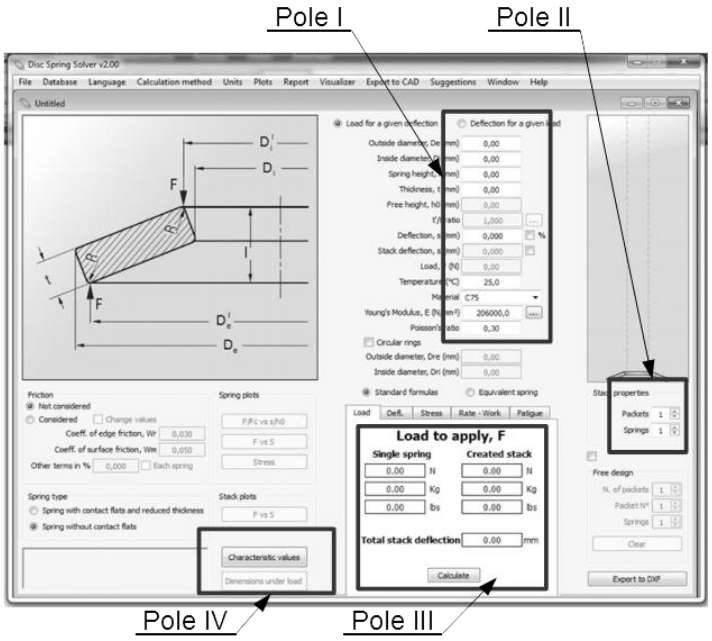

Fig. 3. Window of SPRING ISK SOLVER program for disk spring selection [source: own study]

5. SKID CATCHERS – DESIGN

The characteristic feature of skid catchers is that braking the accelerated car weight must be smooth, so that overload happening in the car during braking ranges from 0.2 to 1 g [10].

The presented idea of catcher has a simple and compact structure. The catcher components are presented in figure 4.

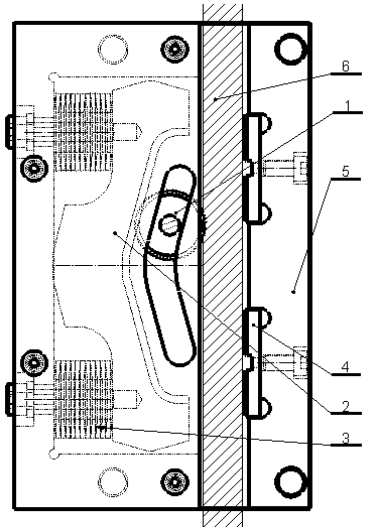

Fig . 4. Structure of skid catcher designed by LIFT Service S.A. [source: own study]

The catcher consists of the body 5, in which a cam 4 is fixed with the use of screws. Between cam 2, and the body 5 there are two packages of disc springs 3, assembled in appropriate piles, securing obtaining proper braking forces. Along cam 2 roll 1 moves, the position of which is controlled by lever which is not shown in Figure 4. The roll cooperates with guide 6 , exerting braking force on a part of it. On the other side of the guide, in the catcher body packing plates are fixed 4, which help to stop the accelerated weight.

6. SELECTION OF DISK SPRING PACKAGE ON THE BASIS OF CATCHER DESIGN

To determine the characteristics of disk spring package the following catcher working parameters were initially determined:

- Nominal lift velocity v = 1,6 m/s,
- Maximum load F = 25000 N,
- Overload coefficient 125%.

Maximum catchers load Q is determined by a mathematical relationship (1):

$$Q = \sum P, K, D, Q \tag{1}$$

where: P – car weight [N],
K – car frame weight [N],
D – car door weight [N],
Q – nominal lifting capacity [N].

During operation tests of the appliance the catchers are overloaded on the basis of standard regulations [10]. In accordance with the relationship (1), the hoisting capacity Q during operation tests must be increased by overload factor of 125%. Therefore, the above relationship takes the following form:

$$Q = P + K + D + 125\% * Q \tag{2}$$

For the considered catchers design the maximum hoisting capacity for which catchers are designed equals 31250 N. In connection with the relationships (1) and (2), the nominal hoisting capacity will equal 25000 N, to which such pile of disk springs should be selected, so that losing the velocity of accelerated weight is possible.

Using the computer application SPRING DISK SOLVER the disk spring package was selected that met the set requirements. Figures 5 and 6 present screen projections from the application, showing particular stages of decision support in selecting spring package.

Figure 5 shows the main program window with inscribed quantities characterrizing the selected disk springs on the basis of catchers design.

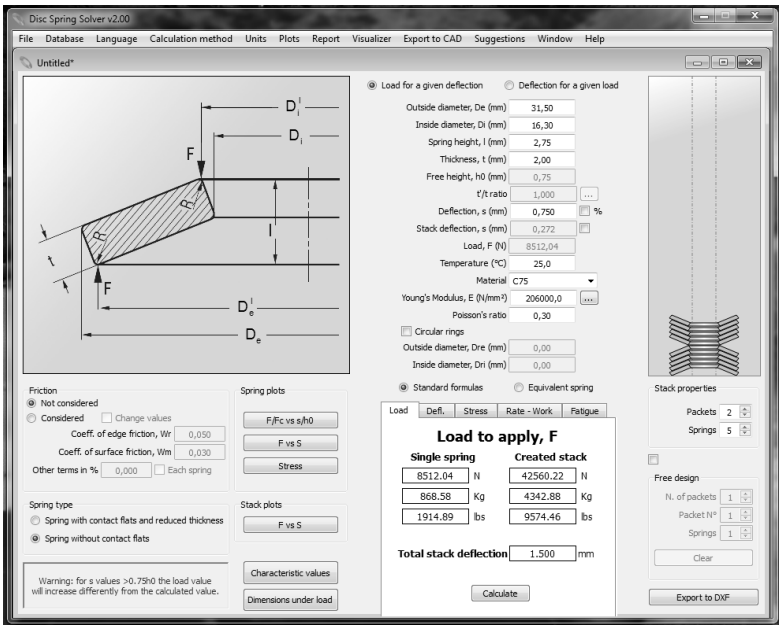

Fig. 5. Main window of Disk Spring Solver application [source: own study]

Figure 6 shows a screen with characterization determined on the basis of the selected disk spring package.

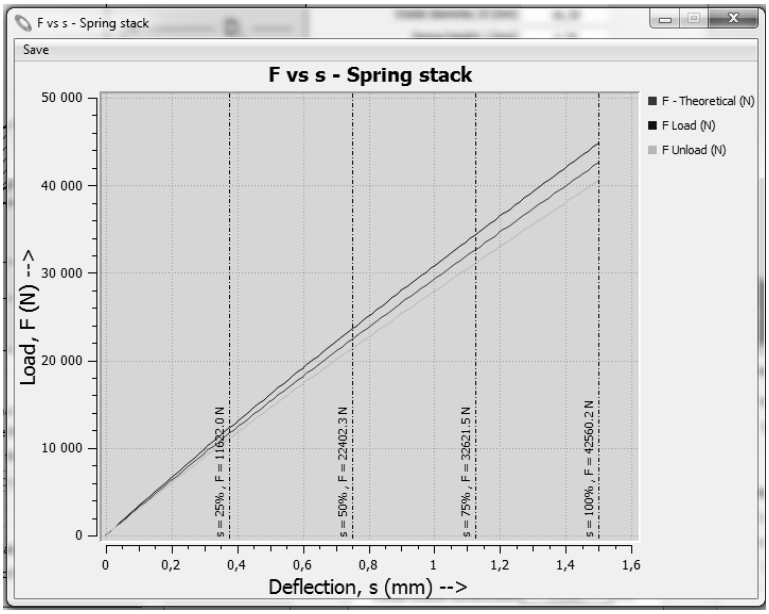

Fig. 6. Deflection characteristics of disk spring package matched with catchers in Disk Spring Solver application [source: own study]

On the basis of the presented characterization we can determine the value of force occurring in each braking phase. The main criterion of determining the value of force with which the spring package affects the roll is the vale of package deflection. According to the standard [11] the value of affecting force depends on the deflection, which is determined on the levels 0,25; 0,5; 0,75 and 100 % of package height. One can read from the presented characterization that for the value designed package deflection the force value is on the level of 32000 N, which, in the considered case is the expected value from design [11].

7. CONCLUSIONS

Supporting virtual prototyping with applications becomes very common in engineering. Such a procedure is connected not only with the possibilities given by the available applications, but also with related savings in constructing expensive prototypes. The foregoing study presents decision supporting connected with fast and easy selection of appropriate set of disk springs in the catcher structure. In the above-described case the presented application gave very positive results as to the changes, which cannot be avoided in the case of prototyping. The authors of many publications emphasize that supporting engineering works in the time of cost restricting becomes more and more common.

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