ANNALS of the ORADEA UNIVERSITY.

Fascicle of Management and Technological Engineering, Volume VI (XVI), 2007

THE INFLUENCE OF THE GEOMETRICAL AND FUNCTIONAL PARAMETERS ON THE FUNCTIONAL PERFORMANCES OF THE SAFETY CLUTCHES

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Keywords: Safety Clutch, Uncoupling Accuracy, Uncoupling Sensibility, Uncoupling Process

Abstract: The paper proposes the study of some diagrams for the moment transmitted by the safety clutches with balls, in static and dynamic working conditions. In this way, there are presented superimposed diagrams plotted for different values of one geometric or functional parameter, and there are analysed both the static diagrams and those dynamical. This study has as an end in view the wording of some recommendations concerning the determination of the shocks values that can be took over by the clutches under dynamic working conditions.

1. INTRODUCTION

The safety clutches with balls are executed in a large variety of constructive solutions, which are different by:

- the shape of the active rabbets,
- the disposal manner of the active rabbets – frontally or radial,
- the arrangement of springs – for each ball or a central one for all balls.

In the uncoupling process, compared to the complete connected working situation, the following changes appear:

- there is a relative motion between the semi-clutches,
- the spring force increases, as a result of the spare compression,
- the dynamic friction coefficient is lower than the static friction coefficient,
- the contact angle between the active elements and also the point of application for the normal reaction are modifying continuously.

For the selection and the comparative study of the safety clutches, it is necessary the use of some parameters that to define the clutch performances.

The main estimation criteria of the functional performances, for the safety clutches, are referred both, to the complete connected working (when the clutch fulfils the main function of torque transmission) and to the uncoupling process (when the clutch develops its safety role, by the limitation of the transmitted torque).

The present paper will mention two of the estimation criteria of functional performances, namely: the uncoupling accuracy and the uncoupling sensibility.

The uncoupling accuracy is the estimation criterion for the fulfilment of a condition required to the safety clutches that is the uncoupling process to start at the same imposed value of the transmitted moment. The uncoupling accuracy is defined as the ratio between the maximum and the minimum value of the moment for what the uncoupling process begins.

The uncoupling sensibility is the estimation criterion for the variation of the ratio between the moment value during the uncoupling process and the moment value during the complete connected working situation (M_{t0}). During the uncoupling process the moment transmitted by the clutch is variable in time and different by the M_{t0}, thanked to the modification – during the uncoupling process – of some constructive and functional parameters of the clutch. The uncoupling sensibility is defined by the ratio between the maximum value of the moment during the uncoupling and the moment value M_{t0}.

2. INFLUENCE OF THE GEOMETRICAL AND FUNCTIONAL PARAMETERS ON THE STATIC AND DYNAMIC BEHAVIOUR

Concerning the parameters that influence the torque transmitted by the safety clutches, under static working conditions, there must be taken into consideration the following aspects [1, 2]:

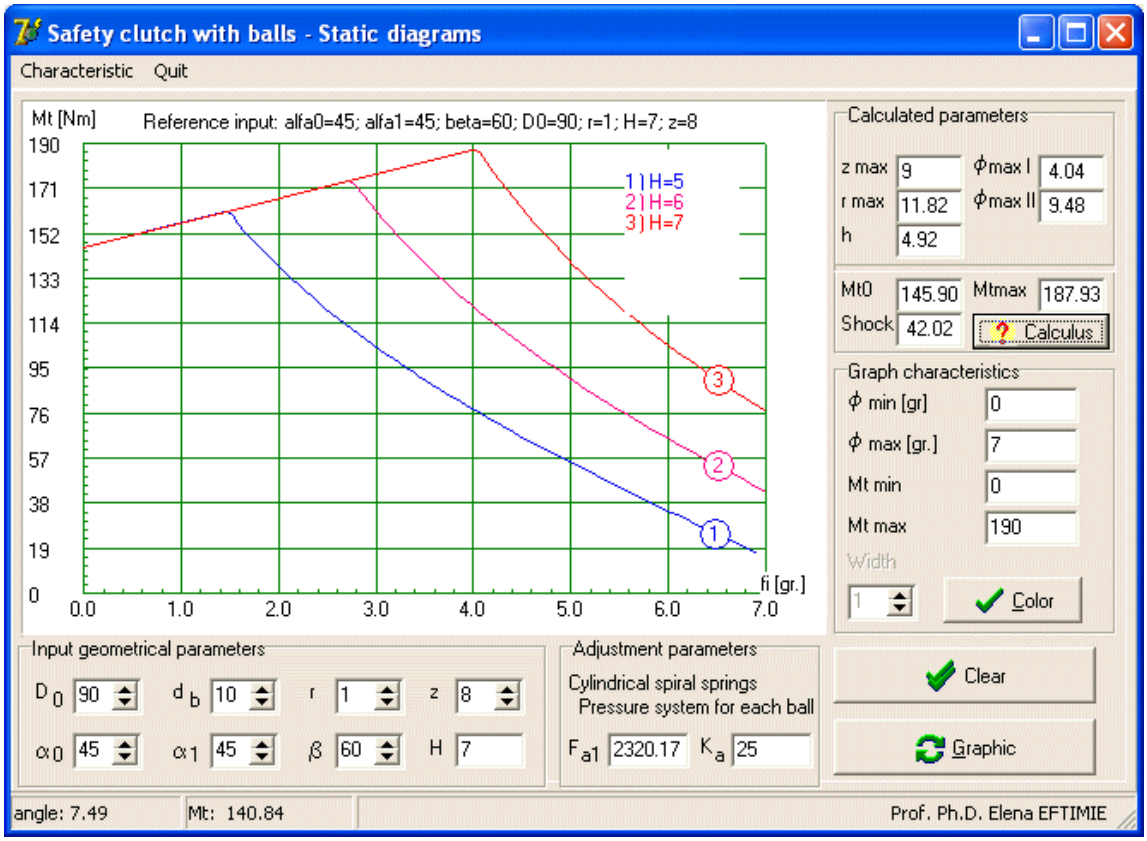
- there are parameters that do not influence the value of the transmitted torque in the complete connected working situation (M_{t0}), namely: the balls diameter (d_b), the fillet corner of the active rabbets from the driven semi-clutch (r), the active rabbet depth (H), the spring rigidity – in the case of spiral springs use (k_a);
- there are parameters that influence the value of the transmitted torque in the complete connected working situation; in fact, these parameters has an influence on the necessary pretension force (F_{a1}), and they are: the diameter of balls arrangement (D_0), the semi-angle of the active rabbets from the driven semi-clutch (α_0), the angle of the adjusting washer (β).

However, it must be mentioned, the parameters mentioned in the first category have still, an influence on the static characteristic of the clutches. This influence is found both, at the level of uncoupling stages duration and concerning the maximum value of the moment at the end of the first stage. In this way, it can be noticed a duration increase of the first uncoupling stage, Figure 1,a, and Figure 2,a, and in some situations even an increase of the second stage too, Figure 2,a.

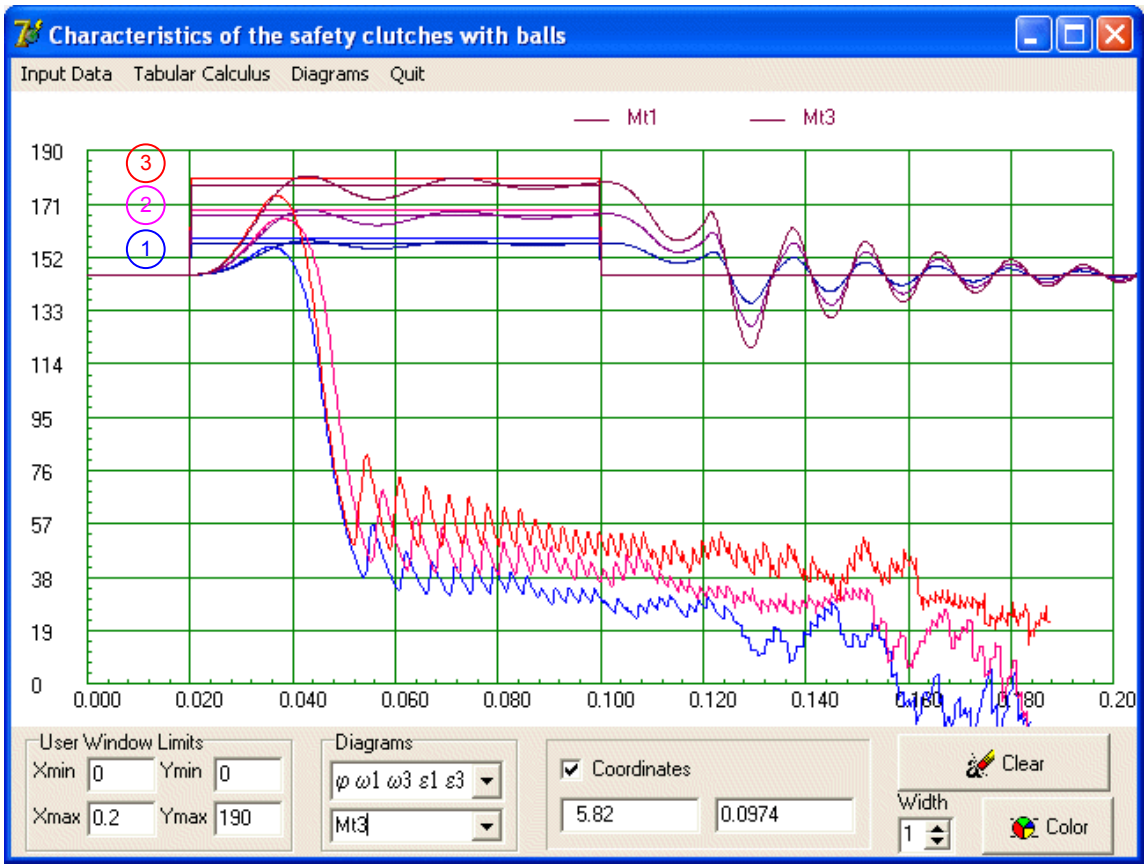
Figures 1,a, 2,a and 3,a present some examples of static diagrams for clutches with one variable parameter (the active rabbet depth – H, the ball diameter – d_b, the spring rigidity – K_a) and the dynamic simulation for these safety clutches, Figures 1,b, 2,b and 3,b. Considering the dynamic simulations, these are made for shock values at the limit of the uncoupling process, namely for every clutch situation are presented both a situation of shock taking over (a shock value near the moment value at the end of the first uncoupling stage, value given by the program of static study) and a situation with a shock value a bit bigger, but that can not be taken over. For the same parameters of a clutch, it was used the same colour for the static and dynamic diagrams the case of shock can not be taken over, and colours darker for the case of shock taking over.

The analysis of the influence diagrams for the parameters presented, leads to the following conclusions:

- the increase of the active rabbets depth leads to the increase of the relative rotational angle corresponding to the first uncoupling stage and, also to its increase for the second uncoupling stage; so that the values of the resistant moment registered during the first and the second uncoupling stages are higher (Figure 1,a); from Figure 1,b, it can be seen that, once with the increase of the active rabbets depth, the shocks values took over are higher, that is a decrease of uncoupling sensibility;
- the increase of the balls diameter leads to a decrease of the relative rotational angle corresponding to the first uncoupling stage, the maximum value of the resistant moment is lower, but the maximum angle corresponding to the complete uncoupling remains constant (Figure 2,a); regarding the dynamic diagrams, Figure 2,b, the increase of the balls diameter leads to an increase of the uncoupling sensibility, the value of shocks that can be taken over decreasing;
- the spring rigidity (Figure 3) has an influence just on the maximum value of the resistant moment registered at the end of the first stage; the increase of the spring rigidity leads to the increase of the resistant moment that can be took over and also to a decrease of the uncoupling sensibility.

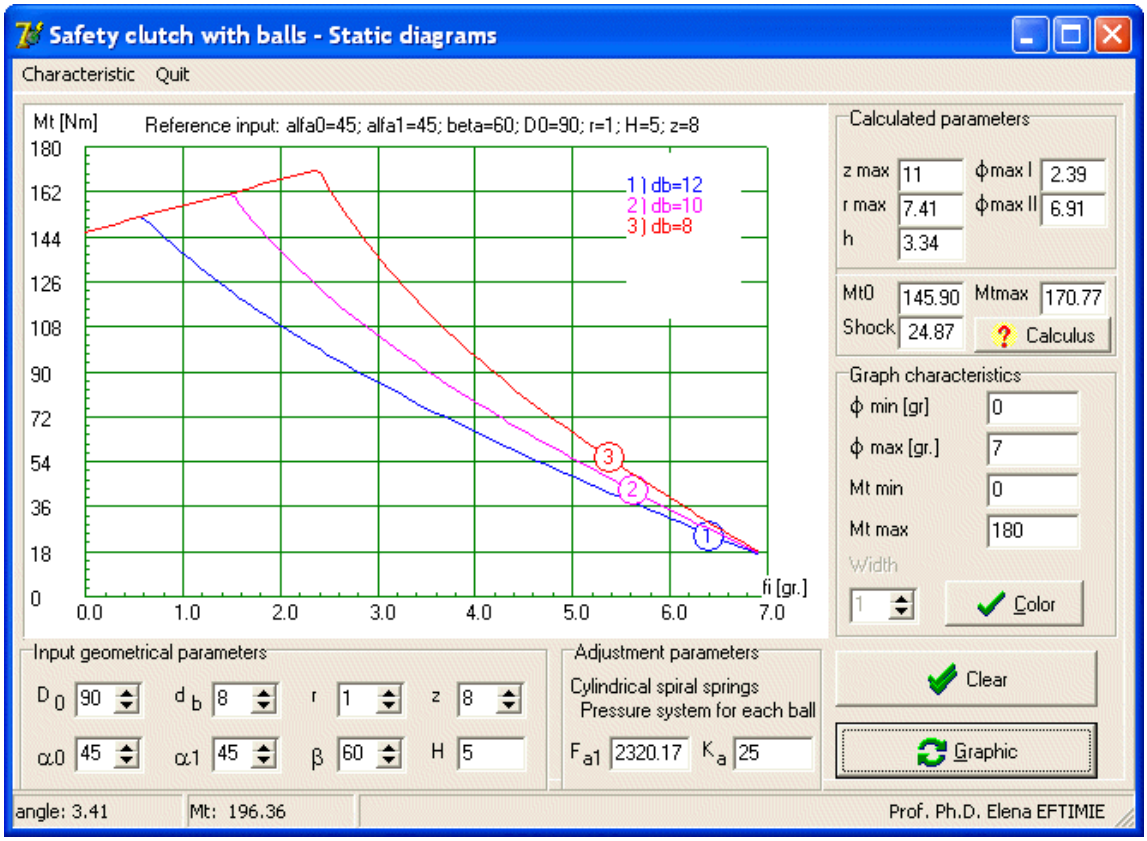


a. static diagrams

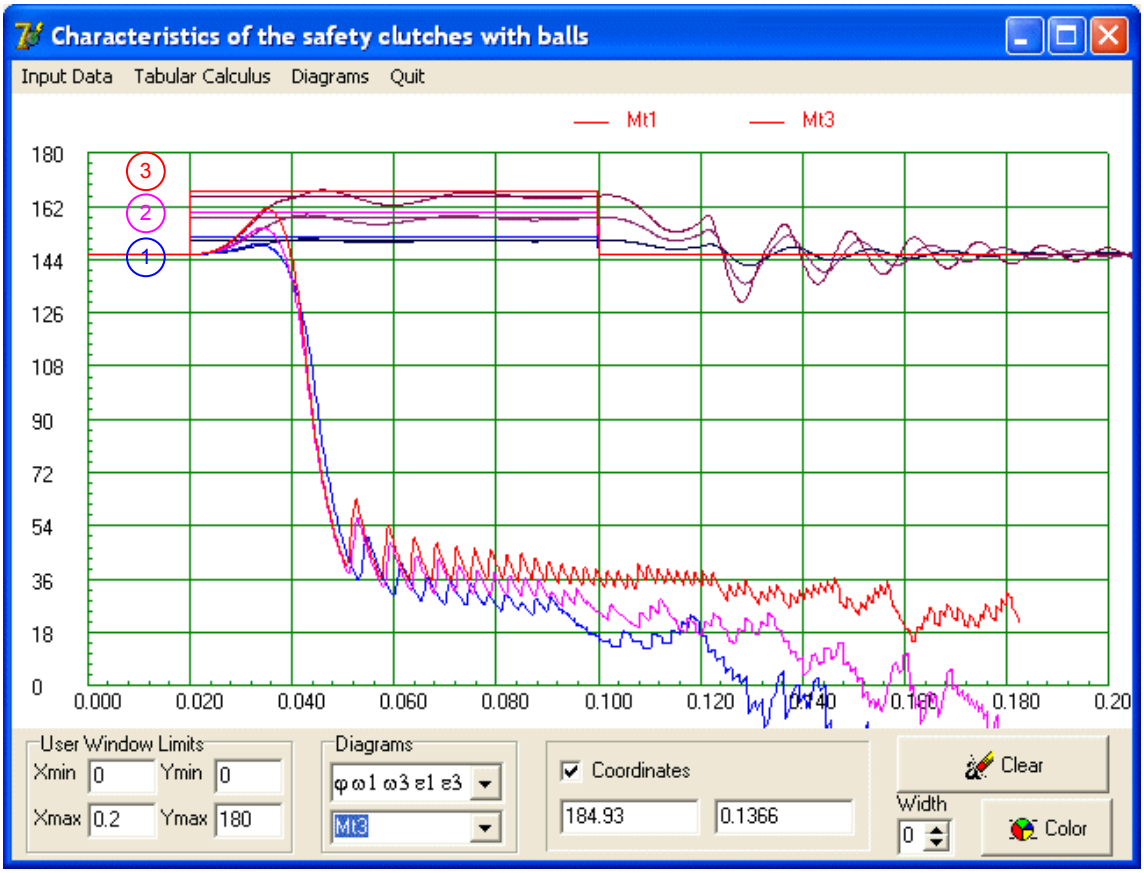


b. dynamic diagrams

Figure 1. The influence of the depth of the active rabbets

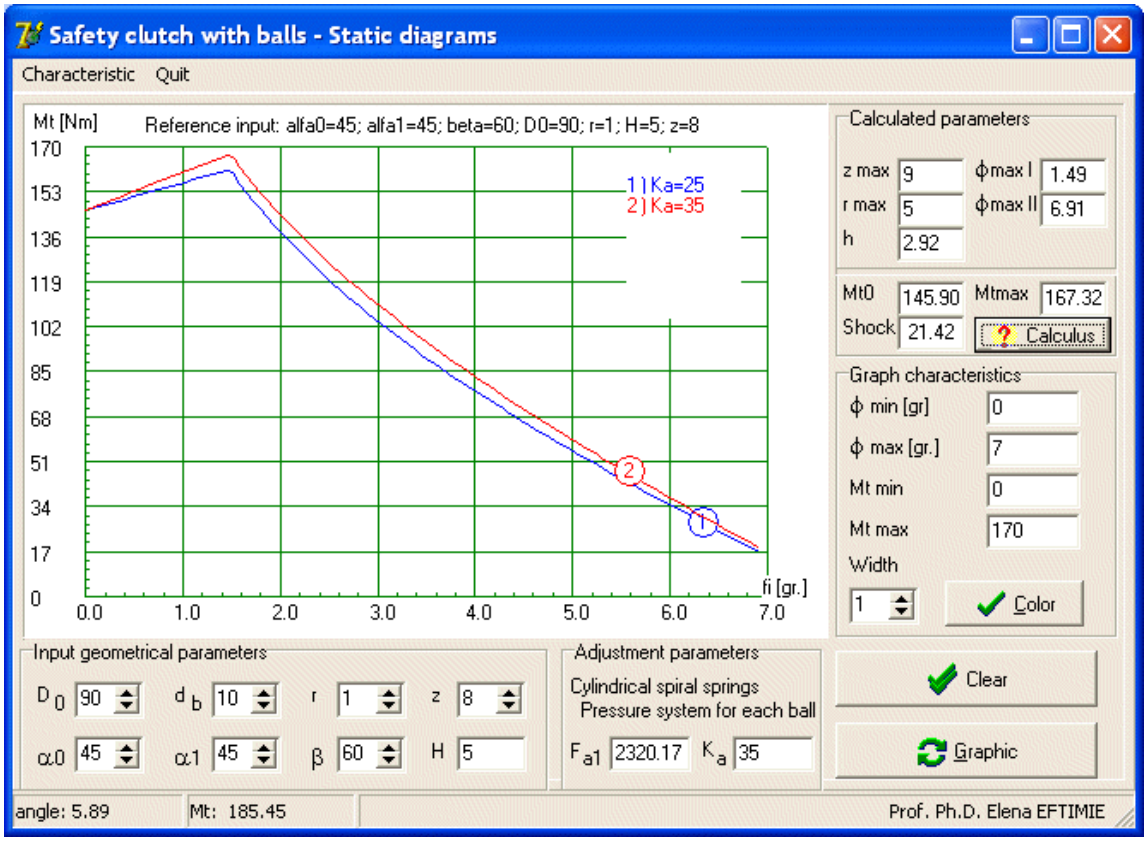


a. static diagrams

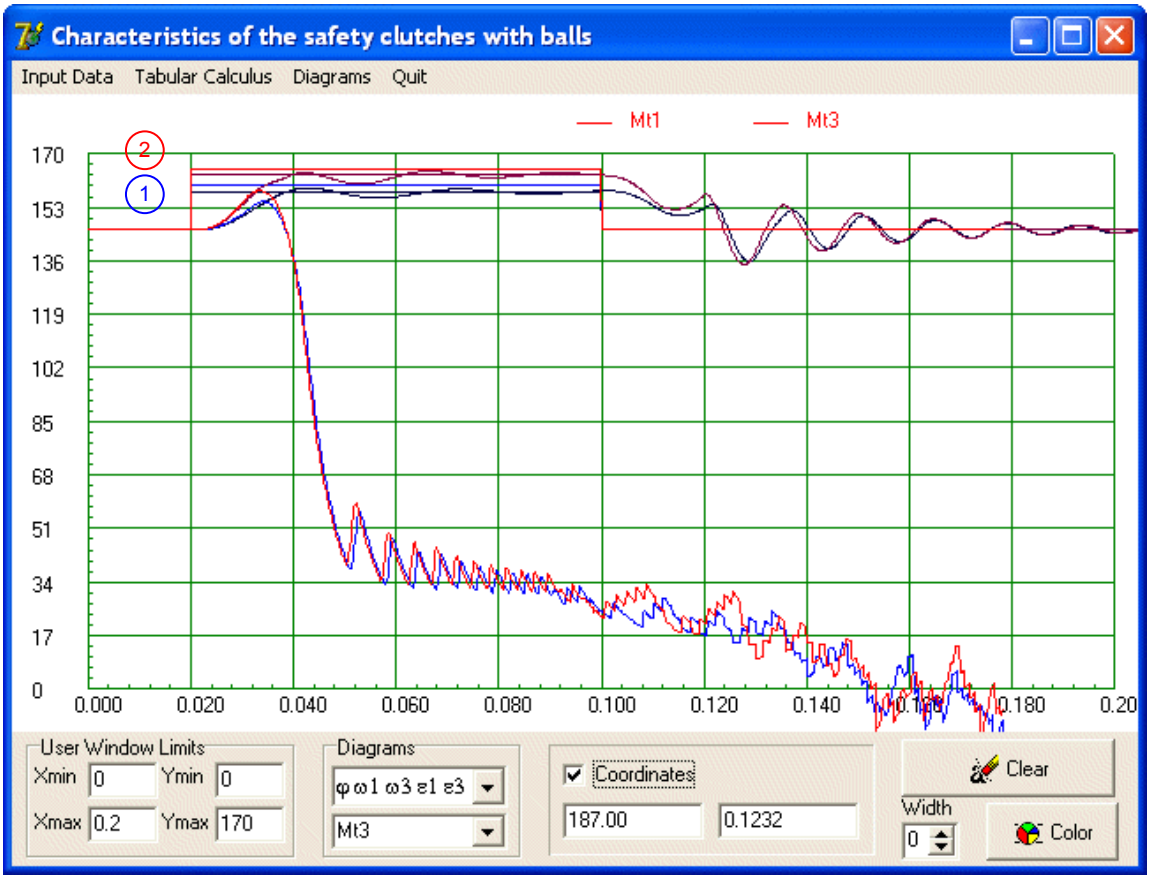


b. dynamic diagrams

Figure 2. The influence of the ball diameter



a. static diagrams



b. dynamic diagrams

Figure 2. The influence of the spring rigidity – Pressure system with springs for each ball

3. CONCLUSIONS

There are situation in practice, when it is desired a certain uncoupling sensibility for a safety clutch. It is very important to have control on the "exact" uncoupling value of a shock. It is taking into consideration that not always it is desired that for the smallest shock, a safety clutch to proceed with the uncoupling process, and there are situation when it is required a known and very precise value of shock for the uncoupling process starting.

This paper proposed, by means of two programs (one for the static diagrams plotting and one for the dynamic diagrams) a study of the influence of characteristic geometrical and functional parameters on the working behaviour of the safety clutches. It is desired that, by a proper analysis of the static diagrams – that are easier to plot – to find the necessary combination of geometrical and functional parameters for a certain uncoupling sensibility.

Therefore, taking into consideration the area where the safety clutch is used and what is the value of the uncoupling sensibility we need, there can be obtained combinations of geometrical and functional parameters that can be used. From these combinations, the designer can select the proper one, depending on the concrete conditions.

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