

# Elastic and Safety Clutch With Axially Distributed Elastic Dowels



## Engineering

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### ABSTRACT

*Within mechanical transmissions, clutches fulfil the function of transmitting the rotational movement from the shaft of a driving element to the shaft of a driven element. However, clutches can fulfil other functions necessary for the good operation of the transmission. From a constructive point of view, clutches can be simple or combined. This paper presents a simple mechanical clutch that is able to fulfil the properties of a mixed one. This new type of clutch represents an optimal solution from the constructive and functional point of view. The design of the clutch allows the combination of the functions of elastic and safety clutches. The clutch's intermediate element between the semi-clutches is the elastic dowel. The paper presents the assembly drawing and the calculus schemes used for the analytical modeling of the torque, which the clutch can transmit.*

### INTRODUCTION

The clutches used in mechanical transmissions can fulfil different functions, which can ensure a good operation of these transmissions. The main function of these clutches is to transmit the rotational movement and the torque from a driving shaft to a driven shaft. The clutches must ensure the proper functioning of the transmission regardless of the technological and assembling conditions of its components.

In technological processes a series of disturbances occur, which negatively influence the operation of the transmission. The clutches are able to take over technological and assembling deviations, torsional vibration and shocks, protection and fitting vibrations of its component machine elements [1], [2].

Besides fulfilling the main function of an elastic clutch and of a safety clutch, the proposed type of clutch is able to fulfil the secondary functions of these two types of clutches. The clutch is a simple clutch, which can have the same functions as a combined clutch by choosing the intermediate elements between the semi-clutches and their layout. The main advantage of the proposed clutch are its reduced dimensions and low cost.

### CONSTRUCTION OF THE CLUTCH

The design of the elastic and safety clutch with axially distributed elastic dowels is based on the following criteria:

- The clutch has to absorb shocks and torsional vibrations;
- The clutch must take technological and assembling clearance;
- The elastic feature of the clutch has to be progressive, which would allow for kinetic energy storage with high damping capacity;
- The load decoupling has to be free of shocks;
- The clutch should allow the changing of rotation direction without shocks;
- Small size and low cost;
- The break of an elastic element should not lead to clutch failure.

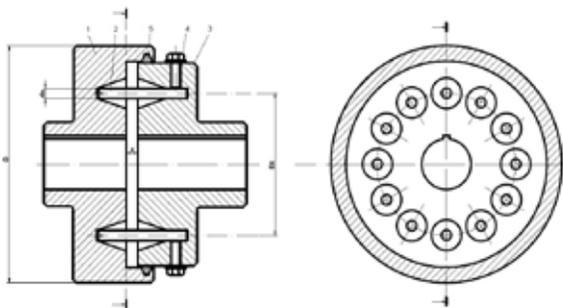


Figure 1: The design of the clutch

In Figure 1, there is presented the elastic and safety clutch with elastic dowels. The components of this clutch are: 1 and 3 represent the two semi-clutches, 2 represents the elastic dowel, 4 represents the screws used for fixing the dowel and, 5 represents the fitting used for sealing.

The rotation is transmitted from semi-clutch 1 to semi-clutch 2 through the elastic dowels. Both of the semi-clutches have equidistant holes in the shape of a conical frustum. The operation of the clutch includes three stages, as follows:

In the first stage, the movement is transmitted between the elastic dowels and the semi-clutch 1, the characteristic of the clutch being linear;

The second stage corresponds to the displacement of the elastic dowel on the conical frustum's generating line; during this stage, the clutch has a nonlinear characteristic.

The third stage corresponds to the load decoupling of the transmission when a resistive moment, which exceeds the maximum moment for which the clutch was designed, occurs.

The relative movement between the semi-clutches will take place from the small base to the big base of the conical frustum. In that particular moment, the load decoupling takes place. In this way, the mechanical transmission is protected. The clutch's stiffness is given by the number of holes and by the number of elastic dowels and their diameter, respectively. The relative rotation angle between the semi-clutches is a function of the number of holes equidistantly spaced and of the radius of the big base of the conical frustum.

### DETERMINATION OF THE TORQUE

Figure 2 presents the geometrical model, which is used for determining the torque.

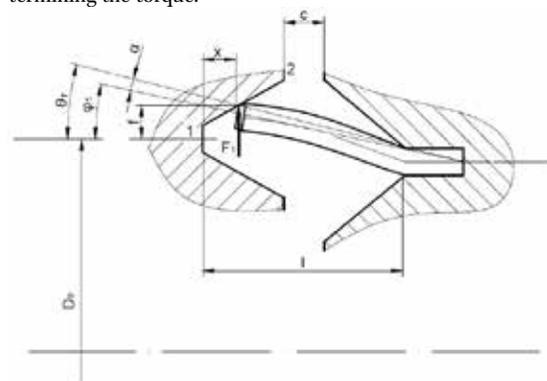


Figure 2: Geometrical model used for torque determination

The elastic and safety clutches have a nonlinear characteristic as presented in Eq (1). Furthermore, the safety condition of the mechanical transmission is presented in Eq (2), [3], [4]:

$$K(\varphi) = \frac{dM_t(\varphi)}{d(\varphi)} \tag{1}$$

$$M_{t\lim}(1 + \Delta) \leq M_{t\max\alpha} \leq \tag{2}$$

Where,

$k(\varphi)$  represents the tangent to the curve of the torsion moment, which is written depending on the relative rotation,  $\varphi$  - represents the relative rotation angle between the semi-clutches,  $M_t(\varphi)$  - the torsion moment corresponding to the clutch deformation with the angle  $\varphi$ ,  $M_{t\lim}$  - represents the torsion moment when the uncoupling produces or ends;  $M_{t\max\alpha}$  - represents the maximum torsion moment admitted by the strength of the most weak clutch element, and  $\Delta$  - represents the relative error reset inputs as function of the clutch.

From Figure 2, the following parameters can be determined:

The tangential force:

$$F_x = \frac{M_x}{z(R_0 + f_x)} \tag{3}$$

The angle of the median string:

$$\theta_x = \varphi_x + \alpha = \frac{F_x x^2}{2EI} \tag{4}$$

For which the following assumptions are considered:

$$\tan \theta_x \cong \theta_x$$

$$\tan(\varphi_x + \alpha) \cong (\varphi_x + \alpha)$$

The arrow:

$$y_x = \frac{F_x x^3}{3EI} \tag{5}$$

$$y_x = \frac{2}{3} x(\varphi_x + \alpha) \tag{6}$$

From equations (3) and (4), the arrow at the end of the elastic dowel can be determined as:

$$f_x = (l - x)(\varphi_x + \alpha) \tag{7}$$

$$f_x = (\varphi_x + \alpha) \left( l - \frac{x}{3} \right) \tag{8}$$

$$M_x = zF_x [R_0 + (\varphi_x + \alpha)(l - x)] \tag{9}$$

The relative rotation angle of the semi-clutches  $\Phi_x$  results as:

$$\varphi_x = \frac{M_x - zF_x R_0}{F_x (l - x)} - \alpha \tag{10}$$

Where,

$M_x$  - represents the transmitted torque,  $z$  represents the number of the clutch's elastic dowels,  $F_x$  represents the tangential force,  $R_0$  represents the disposing radius of the elastic dowels,  $l$  represents the active length of the dowels, and  $x$  represents the distance made by the dowel on the frustum's generating line.

In Figure 3 it is presented the theoretical characteristic of the proposed elastic and safety clutch with axially distributed elastic dowels, which was derived from Eq (1).

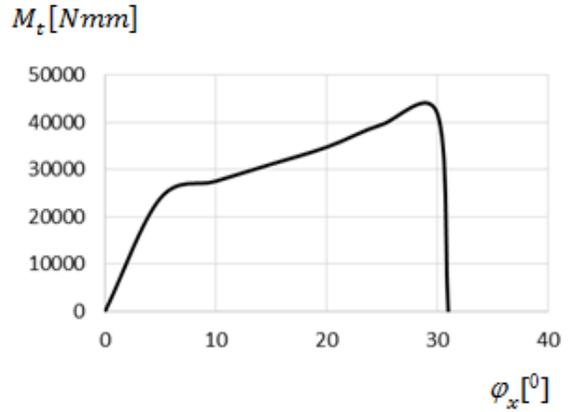


Figure 3: The elastic characteristic of the clutch.

**CONCLUSIONS**

The elastic and safety clutch with elastic dowels has the following advantages:

The clutch can take shocks and torsional vibrations;

The characteristic of the clutch is progressive;

The relative rotation angle between the semi-clutches is a function of the dimensions and the frustum's angle between the generating line and it's base and of numbers of elastic dowels;

When the maximum torque, for which the clutch was designed, is exceeded, the transmission load decoupling takes place;

transmitted the clutch fulfils the safety function by disengaging the transmission from the load;

The clutch can take over technological and assembling deviations;

The clutch might be designed for different torques; moreover, it has a small size and a low cost.

**REFERENCE**

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