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ELASTIC AND SAFETY CLUTCHES WITH METALIC AND RUBBER INTERMEDIATE ELEMENTS IN THE FORM OF AXIALLY ARRANGED CYLINDRICAL ROLLERS

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ABSTRACT

the paper presents the variant of an elastic and safety coupling that has intermediate elements in the structure with the role of taking over the torsional shocks and vibrations as well as the safety function by which the load decoupling of the mechanical transmission takes place when a functional disturbance occurs. The structural diagram of the coupling can be presented which can be made in two variants with metal and rubber intermediate rollers, or only with rubber rollers. In the case of the second variant, rubber rollers, the rollers may be of different elasticities depending on the type of materials in their composition. The constructive form presents the structure of the coupling in the variant with cylindrical rollers located radially on the semi-conductive and driven couplings. The geometrical model is presented and the torque is determined, capable of being transmitted until the load decoupling occurs at the functional disturbances. The characteristic of the coupling with cylindrical rollers with different structure and composition of the non-metallic rollers is presented.

INTRODUCTION

Mechanical couplings are widely used in machine building. The correct choice of these couplings depends on the safe and long-term operation of both the coupling and the kinematic chain within a mechanical transmission with which it is equipped. Mechanical couplings are machine parts that equip and are useful for mechanical transmissions. It ensures the transmission of the rotational motion and the transmission of the torque between two shafts from the engine to the working machine.

In the technique there is a great variety of constructive forms of mechanical couplings. The choice and use of couplings is related to the type and characteristics of the drive machine. Within the kinematic chain that the coupling is equipped with it has the role of ensuring functioning in the nominal parameters of the working machine.

By attaching simple functions to existing coupling constructions and theoretically possible ones, a comb inatorial systematization is achieved, which allows:

- strict systematization of existing couplings, as well as finding those combinations of simple functions for which couplings have not yet been made;
- the correct choice of the type of coupling, suitable for the proposed purpose, knowing the functional parameters that must be met;
- creating new types of couplings, considering the combination of simple functions;
- rigorous approach - from a structural point of view - of all types, existing or possible, of combined couplings.

To obtain multiple functions, the simple functions are combined by obtaining the combined couplings. These couplings are obtained by connecting two or more single couplings. The constructive form will have to fulfill the functional role imposed on the mechanical transmission. The complex functional role imposed on the mechanical transmissions determined the realization of combined couplings, with multiple functions, their functions resulting by cumulating the functions of the simple component couplings. The most commonly used combination couplings are those obtained by serial linking of elastic couplings with safety couplings. The elastic couplings can be with metallic or non-metallic elements, the choice of the elastic material depending on the torque transmitted and the required rigidity. The calculation and design of combined couplings is reduced to the calculation and design of single component couplings.

ELASTIC AND SAFETY CLUTCHES WITH METALIC AND RUBBER INTERMEDIATE ELEMENTS

The generation of elastic and safety coupling takes into account the following objectives:

- the obtained coupling must have a symmetrical construction, in order to achieve simple balancing;
- a semi-coupling must contain a degenerate cam;
- the second semi-coupling must use degenerate fasteners in metallic or non-metallic cylindrical rollers;
- from the point of view of the adjustment of the torque to be transmitted by the coupling, it is possible to make couplings with rubber rollers designed in compliance with the conditions of dimensioning and verification. From a constructive point of view, elastic and safety couplings can be generated in several variants.

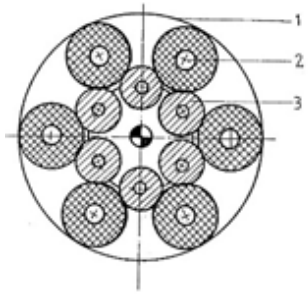

Figure 1 : structure of elastic and safety clutches

Figure 1 shows the structural elastic and safety clutches with rubber intermediate elements in the form of axially arranged cylindrical rollers with the following component elements: 1 the semi-coupling driven with rubber 2 elastic intermediate elements, 3 the conducting semi-coupling which may have metal rollers.

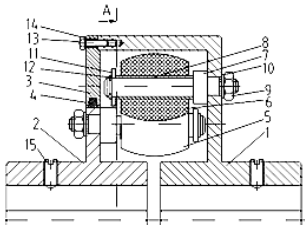

Figure 2: longitudinal section of the clutches ling with metal and rubber rollers

In figure 2 shows a section of the overall design of the elastic and safety coupling with degenerated cam in a radially arranged metal roller assembly and degenerate fasteners in radially arranged rubber rollers so that there is a contact between the non-metallic and the metallic rollers respecting

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the size of the template that allows the compression of the elastic element without destroying this elastic element.

The coupling has the multiple metal rollers 5 slid ably fixed on the bolts 14. The elastic connection between the semi-coupling 1 and the semi-coupling 2 is made by means of the rubber bushes 6, fixed to the bolts 7 by means of the antifriction bushes 8. The load is transmitted from the semi-coupling 2 to the semi-coupling 1 by means of the metal rollers 5, which are in contact with the elastic rubber rollers 6. In the operation of the coupling, two important phases are distinguished: in the first phase, which corresponds to a normal operation of the mechanical transmission, the metal rollers together with the elastic ones, they will coil each other, with a relative movement between the semi-couplings; the second phase corresponds to an overload over the permissible transmission limit, at which point the relative motion between the half-couplings is amplified, the elastic elements deform more strongly, which leads to the interruption of the torque transmission. Due to the elastic elements of the rubber, the coupling is recommended for the transmission of small-medium torque moments.

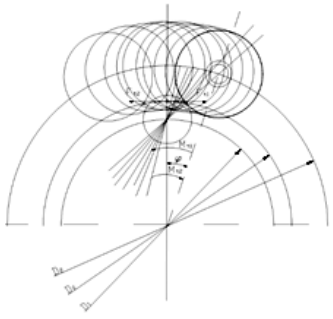

Figure 3: design and sizing calculation scheme

The diameters marked in figure 3 represent:
D1 - the diameter of the arrangement of the steel bushes,
D2 - the diameter of the arrangement of the rubber bushes,
D0 - diameter of the point of contact and application of force for the transmission of the torque

DETERMINING THE TORQUE

The moment of torsion capable of being transmitted, depending on the geometrical elements and the constructive form and assembly, has the following expression:

$$M_{tcap} = \frac{1}{2} D_0 z A_0 E_1 \left(\frac{\varphi_{max}}{\frac{2h}{D_0} - \varphi_{max}} \right) \geq M_{tc} \qquad (1)$$

WHERE:

z - number of rolls placed equiangular,
A_0 - the area of the initial section of rubber elastic elements,
E_1 - the modulus of elasticity of the elastic element in precompressed state,
h - the thickness of the elastic element after precompression,
φ - the relative rotation angle of the semi-couplings.

Feature of elastic and safety coupling with metal and rubber rollers.

Transmission protection condition - equipped with an elastic and safety coupling is

$$M_{t\max} = M_{t\lim}(1 + \Delta) \leq M_{t\max a} \qquad (2)$$

The maximum moment transmitted by the elastic and safety coupling with intermediate rollers with metallic and rubber rollers is a function of the position of the component elements of the structure and the composition of the rubber rollers. An important role in the operation and operation of a mechanical transmission is the characteristic of the coupling. The characteristic of the coupling is the function derived in relation to the time of the torque. The characteristic is determined by the relative movement between the semi-couplings during the mechanical transmission operation. The relative motion between the semi-couplings is given by the relation (3).

Characteristic of the coupling is given by the relationship

$$\varphi = \frac{2M_t h}{D_0\left(M_t + \frac{1}{2} D_0 z A_0 E_1\right)} \qquad (3)$$

To determine the elastic characteristics of the coupling, a stand with closed power circuit is used.

A mechanical brake is used to introduce a resistant moment. The torque of the coupling is determined by a torque sensor mounted in series with the coupling whose characteristic is determined. The relative movement between the semi-couplings is evidenced by two angular position sensors which are mounted by the two semi-couplings.

TABLE – 1 DETERMINARI EXPERIMENTALE

The force applied to the semi-coupling [N]	Relative displacement angle φ[°]
10000	0.3
30000	1.3
50000	2.95
70000	4.85
90000	6.85
100000	7.6
110000	8.3
120000	9.1
150000	12
170000	14.15
180000	14.55
200000	16.5
210000	17.5

Table 1 presents the values of the torque and the angle resulting during the relative displacement between the half-couplings. The increase of the moment is applied until the moment of the load decoupling and of the coupling. The feature shown in Figure 4 is drawn for the intermediate elements where a metal roller has a diameter of 20mm and the diameter of the rubber roller of 25mm. The characteristic is expressed by a mathematical function of degree 3.

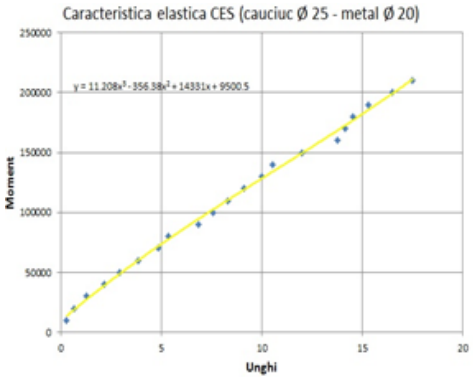

Figure 4: experimental characteristic of the coupling

The characteristic is progressive expressed by a linear function. Load decoupling for the dimensions and structure of the rolls presented around18. The chemical composition of the elastic material from which the rolls are made influences the characteristic of the coupling. The shock and torsional vibration damping is as effective as the larger the diameters of the intermediate rollers and the elasticity of the elastic element is higher.

Starting from the longitudinal section and the representative functions of the elastic and safety coupling, the following requirements of the designed coupling can be formulated, of which we mention:

- the coupling must take the technological and mounting deviations;
- the relative movement between the semi-couples is achieved without shock;
- have a high amortization capacity;
- the coupling has a non-linear characteristic;
- the change of the component elements should be done without dismantling the coupling;
- the change of the sense of rectification to make fierce shocks for the moment;
- the component elements should not be made with projections.

CONCLUSIONS

Following the analysis of the aspects regarding the design, the realization and experimental determinations, the following conclusions can be formulated:

- The design calculation of the coupling is made on the basis of simplifying assumptions, which approximate more correctly the actual functioning of the coupling.
- The experimental feature of the coupling is progressive.
- The construction of the coupling is relatively simple.
- The coupling can take over the technological and mounting deviation
- The coupling allows the damping of the torsional shocks, transmitted in transient regimes of the mechanical transmission.

REFERENCES:

1. Drăghici, I. ş.a., Calculul şi constructia cuplajelor. Bucureşti, Editura Tehică 1978.
2. Dudita, Fl., Diaconescu, D., Optimizarea structurala a mecanismelor. Editura Tehnica, 1987.
3. Moldovean, Gh. Studiul cuplajelor de siguranţă cu transmiterea intermitentea sarcinii. Teză de doctorat. Universitatea din Brasov, 1987.
4. Stroe, I.,Contribuţii teoretice şi experimentale privind conceperea şi modelarea unei noi clase de cuplaje cu funcţii multiple. Cuplaje elastice şi de siguranţă. Teză de doctorat, Braşov. 1999.