ORIGINAL RESEARCH PAPER

Engineering

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

KEY WORDS: Clutches, Elastic, Safety, Function, Simple, Rubber, Shear

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ABSTRACT

the paper presents the variant of an elastic and safety coupling that has intermediate elements in the form of cylindrical rolls of elastic elements with different elasticities and rigidities. The cylindrical rollers are arranged on both semi-couplings the functional contact being realized on the generator realized between the two cylindrical rollers. The structure and the constructive form of the coupling are presented. Starting from the geometric model, the torque and the elastic characteristic of the coupling are determined. The elastic and safety coupling with intermediate elements of elastic rollers too the shocks and torsional vibrations of the mechanical transmission as well as the deviations of position and form respectively the mounting errors. The theoretical and experimental characteristics of the coupling made with elastic elements of different rigidity are determined. The final conclusions highlight the advantage of the new elastic and safety coupling that combines the simple functions of the mechanical couplings by successfully replacing the use of the combined couplings.

INTRODUCTION

A material system (construction, machine or machine organ) is characterized, over a period of time, by a resting state or by a certain permanent movement (regime movement), states considered as reference states. Often, the material system executes movements in relation to the reference state, movements that can be characterized by a certain number of parameters. In the particular case of a technical system, quality means the degree to which the functional, operational and physical properties and requirements are met, established according to the purpose of use. The development of mechanical systems with high reliability is possible only within a coherent system of reliability assurance.

Often on a mechanical system several simultaneous vibrations operate. For the study, as well as for its correct design, we must take into account the effect of the resulting vibrations. The reduction to acceptable values of the vibrations is achieved by using the different organs of machines, which allows by the construction, the way of placing the component elements and the materials used to reduce these functional disturbances of the system. Mechanical couplings as part of a technical system (mechanical transmission) allow by means of the design and choice of the component elements to reduce the level of vibration and torsional shocks

In the mechanical transmissions an important role is played by the elastic mechanical couplings respectively the safety couplings. These are complex machine parts with the role of protecting the mechanical transmission against shocks and torsional vibrations and at the moment exceeding the limit able to be transmitted to decouple the transmission until the defect is eliminated. In the technique there are situations in which the functions of the different simple mechanical couplings must be combined, resulting in a combined coupling which includes the functions of those connected in series or in parallel. Most commonly used couplings combine the functions of an elastic coupling with the functions of a single elastic coupling. Combined couplings have large dimensions and high costs.

The coupling proposed in the paper is a simple multi-function coupling that combines the functions of an elastic coupling with the functions of a safety coupling. Elastic and safety coupling with elastic intermediate elements in the form of cylindrical rollers. The coupling has a simple construction with small dimensions and low costs.

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

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

- the obtained coupling must have a symmetrical construction, in order to obtain a simple balance;
- the replacement of some component element of the coupling structure is done without dismantling the coupling from the mechanical transmission
- a semi-coupling must contain a degenerate chamber in non-metallic rolls;
- the second semi-coupling must use degenerate fasteners in non-metallic cylindrical rollers;
- from the point of view of adjusting the torque to be transmitted by the coupling, it is possible to make couplings with rubber rollers designed according to the conditions of dimensioning and verification.
- from the constructive point of view, elastic and safety couplings can be generated in several variants.

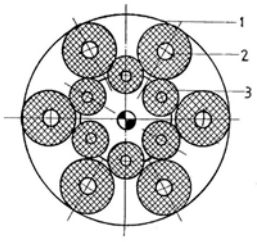

Figure 1 : structure of elastic and safety clutches

Figure 1 shows the elastic and structural safety clutches with rubber intermediate elements, in the form of cylindrical rollers arranged axially with the following component elements: 1 semi-coupled driven with non-metallic rollers, 2 elastic intermediate elements, 3 semi-coupling with non-metallic roller conductors. The elastic and safety coupling with rubber rollers is part of the category of couplings derived from degenerate cam mechanisms and degenerate studs.

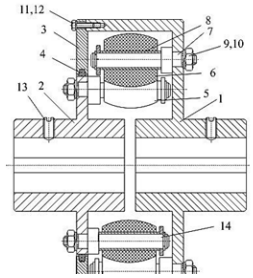

Figure 2: longitudinal section of the coupling with rubber rollers

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Figure 2 shows the overall design of the elastic and safety coupling. The rubber roller elements 5 (semi-coupling 2) are slidably fastened to the bolts 9. The elastic connection between the semi-coupling 1 and the semi-coupling 2 is made by means of the rubber bushes 6 (semi-coupling 1), fastened to the bolts 7 by the anti-friction bushings 8. Sealing. the coupling is made by means of the flange 3, provided with a felt sealing system 4.

The load is transmitted from the semi-coupling 2 to the semi-coupling 1 through the rubber rollers 5 (the semi-coupling 2), which are in contact with the elastic rubber rollers 6 (the semi-coupling 1). In the operation of the coupling there are two important phases: in the first phase, which corresponds to a normal operation of the mechanical transmission, the rubber rollers will wind each other, taking place 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, the coupling is recommended for the transmission of small to medium torque moments.

Figure 3 shows the geometric model that allows to determine the torque and the characteristic of the elastic and safety coupling with rubber intermediate elements

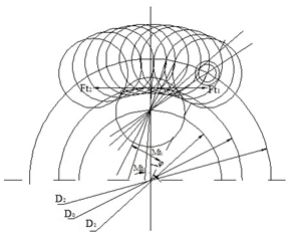

Figure 3:calculation scheme for determining the torque and elastic characteristic

WHERE:

D1 - the diameter of the semi-coupling rubber bushings 2,

D2 - the diameter of the arrangement of the rubber bushes of the semi-coupling 1,

D0 - diameter of the point of contact and application of force for the transmission of the torque

DETERMINATION OF TORSION TIME AND ELASTIC CHARACTERISTICS

$$Mt_{max} = \frac{1}{2} D_1 z2(dl)\sigma_{as} = D_1 z dl \sigma_{as} \qquad (1)$$

$$\sigma_{as} = 5...7N/mm^2$$

M_{tmax} the maximum torque required by the system

- Calculation of dimensioning of elastic coupling and safety with rubber rollers

$$M_{tcap} = \frac{1}{2} D_0 z 2 A_0 E_1 \left(\frac{\varphi_{max}}{\frac{4h}{D_0} - \varphi_{max}} \right) \geq M_{tc} \qquad (2)$$

WHERE:

z - number of rolls placed equilegular,

A0 - the area of the initial section of rubber elastic elements,

E1 - the modulus of elasticity of the elastic element in precompressed state,

h - the thickness of the elastic element after precompression,

- the relative rotation angle of the semi-couplings

FEATURE OF ELASTIC AND SAFETY COUPLING WITH RUBBER ROLLERS

$$\varphi = \frac{4M_t h}{D_0 \left(M_t + D_0 z A_0 E_1 \right)} \qquad (3)$$

TABLE – 1 DETERMINARI EXPERIMENTALE

The force applied to the semi-coupling [N]	Relative displacement angle φ [°]
10000	2.75
20000	5.75
30000	7
40000	7.8
50000	9.7
60000	10.1
70000	10.3
80000	12.6
90000	12.7
100000	15.04
110000	17.5
120000	18
130000	19.3
14000	20.2
15000	22

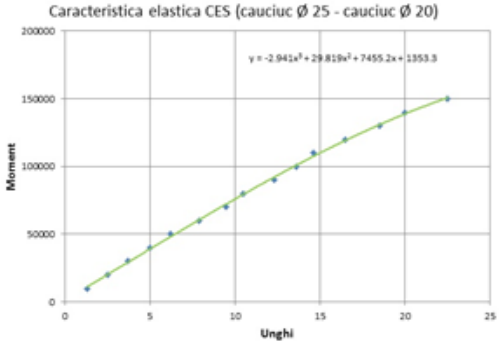

Figure 4: experimental characteristic of the coupling

The coupling feature is a progressive feature. The coupling transmits relatively large moments for angular displacements of the order of the tens of guards (22.5°). The load decoupling is according to the diameter of the rolls arrangement within the respective semi-coupling and the diameter of the rollers

The constructive solution of elastic coupling and safety presented has the following advantages:

- ensures the compensation of axial, radial and angular deviations, within the wide relative limits;
- ensures good cushioning of torsional shocks and vibrations, through the mobile contact between: the elastic elements and the degenerate cam of the driven semi-coupling; between the rubber rollers of the two semi-couplings;
- different elastic characteristics can be obtained, depending on the constructive form, the nature of the elastic element, as well as the mode of arrangement within the coupling;
- ensures a relative rotation between the two semi-couplings depending on the nature and the arrangement of the component elements of the semi-couplings, over the allowed limits, the elastic coupling becomes a safety one;
- ensures the limitation and adjustment of the torque that can be transmitted;
- the presented coupling has a simple construction, small dimensions and a low cost, compared to the combined ones that perform the same functions.

Following the analysis of the experimental characteristics of the 4 variants of rubber intermediate elements, the following

characteristics can be formulated, figure 5:

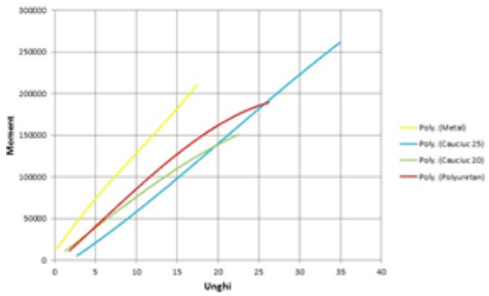

Figure 5: experimental characteristic of the coupling

CONCLUSIONS

- The characteristic of the coupling with metallic and rubber rollers has a progressive form of polynomial equation of degree 3.
- The clutch transmits lower torque for different angular displacements compared to the clutch having both F25 rubber rollers.
- The characteristic of the coupling that has in its structure non-metallic elements with different diameters and different rubber compositions, is a progressive characteristic of polynomial equation of degree 3.
- The moments transmitted by the coupling having in its structure rollers of different diameters and the same chemical composition, are smaller having a less rigid characteristic than those using polyurethane rollers, because the hardnesses are different.
- For rubber rollers of different diameters, the relative rotation angle between the semi-couplings is reduced depending on these diameters.
- The relative rotation angle between the semi-couplings differs from the number of rollers placed on the coupling, the diameter of the rollers and the chemical composition of the non-metallic elements

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