VOLUME-8, ISSUE-11, NOVEMBER-2019 • PRINT ISSN No. 2277 - 8160 • DOI : 10.36106/gjra

Original Research Paper

Engineering

ELASTIC AND SAFETY COUPLING WITH ELASTIC RUBBER ELEMENTS

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ABSTRACT The paper presents a mechanical coupling with elastic intermediate elements. The coupling through the constructive form and the intermediate elements components combine the functions of two mechanical couplings. In mechanical transmissions the reduction of shocks and torsional vibrations is realized using elastic couplings. Load decoupling at the occurrence of defects in the mechanical transmission is achieved by means of safety couplings. The combination of the functions of the two couplings is achieved by the series or parallel connection of an elastic coupling and a safety one resulting in a combined coupling. The structure of the elastic and safety coupling of rubber elements in the form of shoelaces is presented. The torque that the coupling transmits is determined. The elastic characteristic and the loading-unloading curve highlight the properties of the new coupling.

KEYWORDS : clutches, elastic, safety, function, simple, rubber, shear

INTRODUCTION

In order to transmit the rotational movement from the motor car to the working machine it is necessary to implement an intermediate element, mechanical coupling. The role of the coupling is to perform the basic function, transmitting the rotation motion and the moment of distortion. In the case of mechanical transmissions, for the functioning in the nominal parameters it is necessary to introduce the various additional functions. The combination of the secondary functions leads to the constructive and functional generation of the different types of couplings. Combined couplings in most cases combine the functions of elastic couplings and safety couplings.

The elastic couplings are characterized by the property of taking over the shocks and torsional vibrations by storing kinetic energy when a functional disturbance of the mechanical transmission occurs. When these disturbances disappear, the stored energy is returned to the mechanical system. The safety coupling has the role of protecting the mechanical transmission by decoupling the load in the event of an overload during operation. The design of the safety elements allows protection up to the limit torque value up to which the transmission is protected

Elastic And Safety Clutch With Rubber Intermediate Elements

The elastic and safety coupling with rubber intermediate elements is characterized by specific technical and functional functions. These are: it ensures the connection between two shafts of a mechanical transmission by transmitting the torque and the rotation motion; when the limit momentum exceeds the power flow is interrupted, and if the defect disappears the coupling can take over its functions; the load decoupling is achieved by compressing the rubber within the limit of the design and dimensioning calculation.

The paper presents an elastic and safety coupling whose structural scheme has the constructive form of figure 1, structural diagrams of the coupling with rubber springs in the form of shoes.

The paper presents an elastic and safety coupling whose structural diagram has the constructive form of figure 1 with the following component elements 1 driven semi coupling, 2 elastic intermediate element, 3 conductive coupling - equilateral cam.

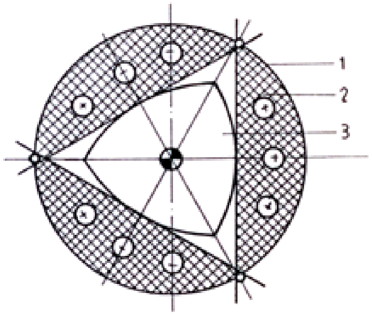

Figure 1: structural diagrams of the coupling with rubber springs in the form of shoe

Establishing the design and verification relationships of the elastic and safety coupling with rubber shoes and elastic elements will be carried out and follow the steps as in the case of the linear characteristic couplings, but applying the particularities related to the operation of the non-linear characteristic couplings. According to the literature, a series of calculation hypotheses can be enumerated to allow optimum sizing of the coupling with non-metallic elements arranged equiaxially. It is necessary to establish calculation relationships that determine the correct sizing of the coupling for the input parameters imposed.

The following calculation assumptions are accepted for the calculation and dimensioning:

- The elastic element of the coupling is considered symmetrically loaded;
- The elastic element consists of three rubber pads and the elastic blades with the protective role of the rubber elements.
- The relative movement between the semi-couplings is made between the echelonial cam and the elastic blades, during the coupling operation. Linear, radial and angular displacements may occur between the cam and the blades;
- Due to the relative movements between the elastic elements and the cam, frictional forces appear between them, which can be considered as evenly distributed on the contact surfaces;
- The relative rotation of the semi-coupling introduces between the elastic elements bending and crushing requests;
- The mounting games influence the relative rotation angle of the semi-couplings in the sense of increasing them due to their processing during operation;

- When radial, angular, or combined dexterities occurs, the elastic elements are additionally required;
- The elastic elements are deformed by accumulating potential deformation energy, which allows to determine the momentary jumps, which can be taken up by the coupling.

In accordance with the geometrical model adopted in figure 2 and the calculation premises, the determination of the torque is performed based on the following calculation schemes.

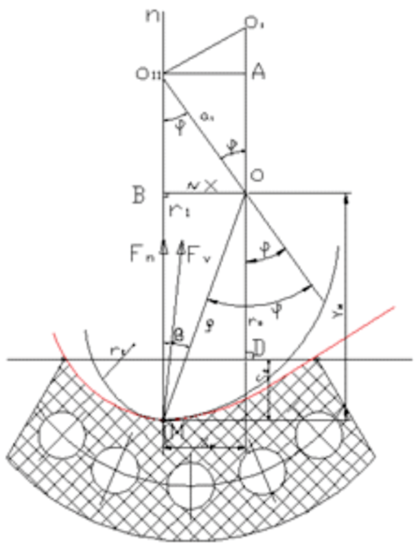

Figure 2: calculation scheme with element that allows the rubber debate

The torque transmitted by the coupling has two components - T1 determined by the normal force and the OB arm, respectively T2 under the action of the normal force and the distance from the center of rotation of the coupling r1 to the normal nn at the contact point between the equilateral cam and the elastic protection blade, of rubber shoes.

$$T = T_1 + T_2 \quad (1)$$

$$T_1 = nF_n OB = n(F_v x_M + F_o y_M) \quad (2)$$

$$T_2 = nF_n r_1 \quad (3)$$

$$T = 2n[F_v x(\varphi_1) + \mu F_v (r_0 + S_2(\varphi_1))] = 2nF_v[x(\varphi_1) + \mu(r_0 + S_2(\varphi_1))] \quad (4)$$

Explicit relationships implies knowing the sizes Fv, x (φ1) and S2 (φ1). According to the relations and the calculation premises the equation of displacement S2 (φ1) (of the average fiber and deformation of the rubber). By replacing the arrow S2 (φ1), the position x (φ1) and the vertical force Fv the expression of the torque becomes

$$T = 2nF_v[x(\varphi_1) + \mu(r_0 + S_2(\varphi_1))] = 6nEI_z l \frac{r_1 - r_0 - a_1 \cos\varphi_1}{\left(\frac{1}{2} - a_1 \sin\varphi_1\right)^2 \left(\frac{1}{2} + a_1 \sin\varphi_1\right)^2} \cdot [a_1 \sin\varphi_1 + \mu(r_1 - a_1 \cos\varphi_1)] \quad (5)$$

Based on the relation (4) the elastic characteristic of the coupling can be determined.

$$K(\varphi) = \frac{dT(\varphi)}{d\varphi} \quad (6)$$

The determinations were made for the coupling with degenerate studs in rubber springs in the form of shoes. The following figure shows the elastic feature for elastic and safety coupling and rubber shoes.

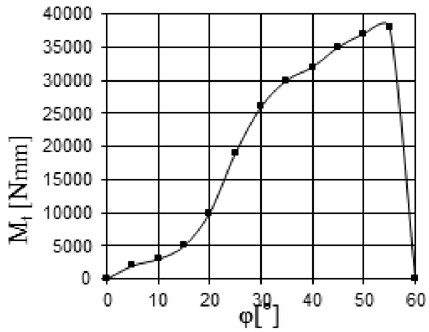

Figure 3: elastic feature of elastic and safety coupling with rubber springs in the form of shoe

From the comparative analysis of the obtained characteristics, the following significant appraisals emerge:

- The feature is progressive;
- The coupling has a high elastic deformation capacity, with the relative turning angle depending on the number of cam profiles;
- Due to the high elasticity, the coupling has a great capacity to cushion the shocks and torsional vibrations;
- Coupling with rubber shoes transmits higher torque;
- The rubber shoe coupling transmits torque at a relative rotation angle between semi-couplings up to 55°, after which the load shearing without major shocks takes place;
- In figure 4 a curve of loading and unloading of the coupling with rubber shoes is shown, in which the discharge curve is a function of the hysteresis of these rubber shoes and the curve of the cam profile.

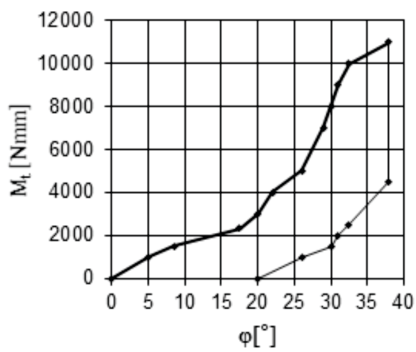

Figure 4: Load and unload curve of the coupling with rubber shoes

Although the construction of elastic and safety couplings is relatively simple, the calculation of these couplings is a very complex problem, due to the phenomena that appear in operation, presented below.

- There is a slip and therefore friction between the elastic blades fitted to protect the rubber and the shaft cam.
- There is a sliding between the elastic blades and the bolts on which they rest.
- The support points on the bolts of the blades are modified.
- The contact points between the cam and the elastic blades respectively the rubber shoes are changed.
- The contact between the cam and the elastic blades takes place on a surface.
- There is rubbing between the cam and the blades.
- There is rubbing between the elastic blades and the rubber shoes.
- In the case of the constructive solution of the elastic and safety coupling ESC with rubber springs in the form of shoe pads, the elastic characteristic of the non-metallic elements is difficult to mathematically model.
- In the case of elastic and safety coupling, a mathematical

model that exactly describes its operation is very complex; therefore it is necessary to introduce simplifying calculation hypotheses, but to approximate as accurately as possible the actual functioning of the coupling.

- In this respect, we will present the calculation hypotheses adopted for the elaboration of a general algorithm for designing the elastic and safety coupling (CES), taking into account the mathematical and physical, theoretical and experimental models presented in the previous chapters.
- The three blades are identical, homogeneous and isotropic.
- The representative blade is considered to be freely supported on one bolt and hinged on the other.
- The effects due to the thickness of the bolts are neglected; as a result, the supports of the blade are considered point form, the distance between them being equal to the distance between the centers of the bolts.
- The cam acts on the blade and the rubber shoes with a force oriented according to the common norm in the theoretical point of contact between them; the frictional force generated by the normal force changes the direction of the resulting cam-blade reaction, with the friction angle.
- Because the height of the cam is small compared to the opening of the blade supports, the angular deformations of the cam are small (below 8° ... 10°); as a result, in establishing the average fiber, it is considered that only the normal concentrated force acting on the blade acts on the blade.
- The effects of the friction between the blades and the supports, respectively the blades and shoelaces, are neglected.
- In calculating the torque, the effects of the normal force and the effects of the friction force generated by them are considered; because the deformation angles of the blade are small, the normal force is considered vertical and the friction force will be considered horizontal.
- The contact between the blades and the cam, the shoe blades are considered the line; by reducing the calculations to a cross section by coupling, the cam-blade contact is reduced to a point. The force between the blade and the cam is considered applied at the point of contact; the force acting on the blade determines its bending, and reaction on the cam balances the transmitted torque

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.

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