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Study on the loading capacity of the tripod type couplings with external contacts

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Abstract. The paper presents the study of the contact pressure of the tripod couplings with external contacts, in order to identify the geometries of the contact elements which assure higher loading capacities. The article starts with the study of the literature; there are identified the main conclusions regarding the loading capacity, the life time and the forces which are acting between the elements. For the geometrical modelling of the tripod coupling with external contacts there are considered three variants for the shape of the elements which are in contact: cylinder on cylinder, parabolic on parabolic and hyperbolic on hyperbolic. The pressure contacts are determined by achieving a finite element analysis for all the geometric variants. The finite element analyses is performed for a set of values for the contact force as 100 N, 200 N, 300 N, 400 N and a set of values for the angle between the input and the output shaft as 0^o, 10^o, 20^o, 30^o. Finally there are identified conclusions regarding the variation of the contact pressure with the applied normal force and with the angle between shafts; it is identified the variant of the contact geometry which assure the highest loading capacity.

1. Introduction

The tripod type couplings are widely used in car suspensions mechanisms and in the transmissions of the machine-tools as rolling mills. Due to their properties as quasi-homokinetic couplings, they may be used in single or in combination with another identical coupling, as double couplings [1].

The loading capacity of the tripod couplings is studied in the literature, mainly by studying the contact stresses by performing numerical calculus and tests. In [2] is studied the dynamic behaviour of a tripod ball joint by considering a Hertzian contact without considering the friction forces; the conclusion is that the higher loading capacity tripod couplings have a better dynamical behaviour.

A multibody flexible dynamics analysis with finite element method is presented in [3] in order to predict the contact stresses evolution in time for ball and tripod types constant velocity joints. Constructive solutions are given, by using the finite element analysis, in [4] for increasing the strength and the fatigue life of a tripod transmission used in vehicles.

In [5] and [6] are given conclusions regarding the torques and the forces which are acting in a tripod sliding universal joint: the amplitude of the forces and the torques at the revolute joint is decreasing with the increasing of the mass and the rotating radius of the slide rods; the increasing of the joint angle produces the increasing of the forces at the input shaft. The influence of the loading capacity of the mechanical couplings on the other components of the mechanical transmission nis presented in [7].

The classical tripod type couplings have a construction with an internal contact between the driver (mainly a roller) element and the driven (mainly a cylindrical shaped housing) element.

In order to reduce the local contact pressures between the driver and the driver element, and due to this, in order to increase their loading capacities, the tripod type couplings with external contacts are used. The paper presents the study on the loading capacity of the tripod type couplings with external contacts, by analysing the local contact pressures. The studies are presented by considering different type of surfaces being in contact between the driver and the driven elements and different angles between the driver and the driven shafts.

2. The modeling of the tripod coupling with external contacts

The tripod coupling with external contacts assures a rolling friction between the elements being in contact between the driver 1 and the driven 2 elements [8] – figure 1.

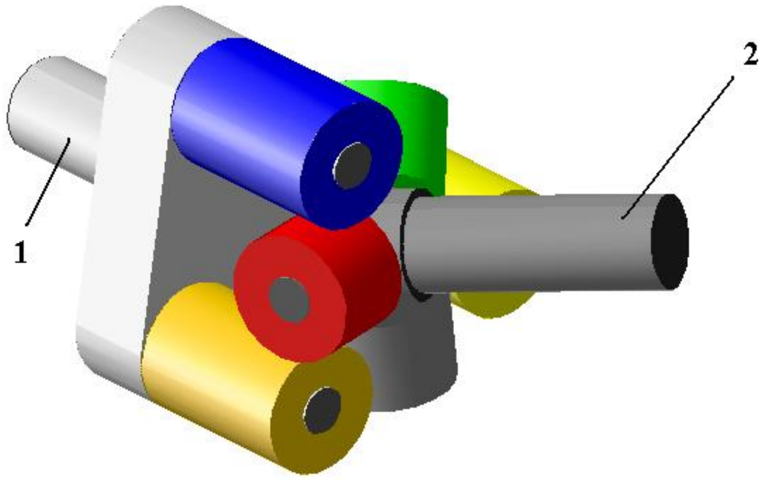

Figure 1. The tripod coupling with external contacts.

The contact elements could have different shapes which are studied in the next steps by using the finite element method, in order to find solutions with small contact pressures and, due to that, higher loading capacities; apart of the cylinder on cylinder contacts there are studied the solutions with parabolic on parabolic and hyperbolic on hyperbolic shape contacts [9], [10] – figure 2.

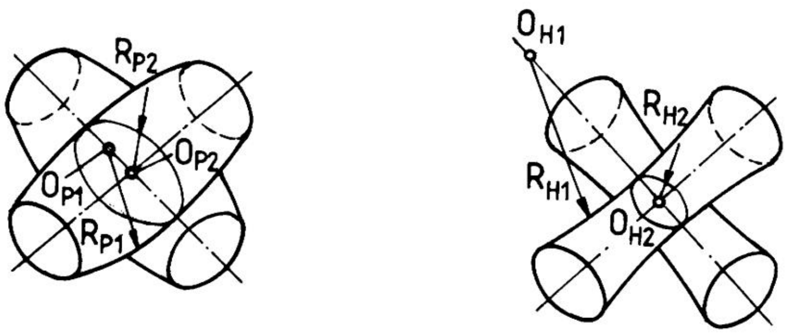

Figure 2. The parabolic and hyperbolic shape contacts.

In order to perform the finite element analysis, the elements being in contact are modelled in *Catia* software – figure 3. In the analyses it is considered an angle between the input and the output shaft between α=0° ... 30°; the contact force has a variation between F=100 N ... 400 N.

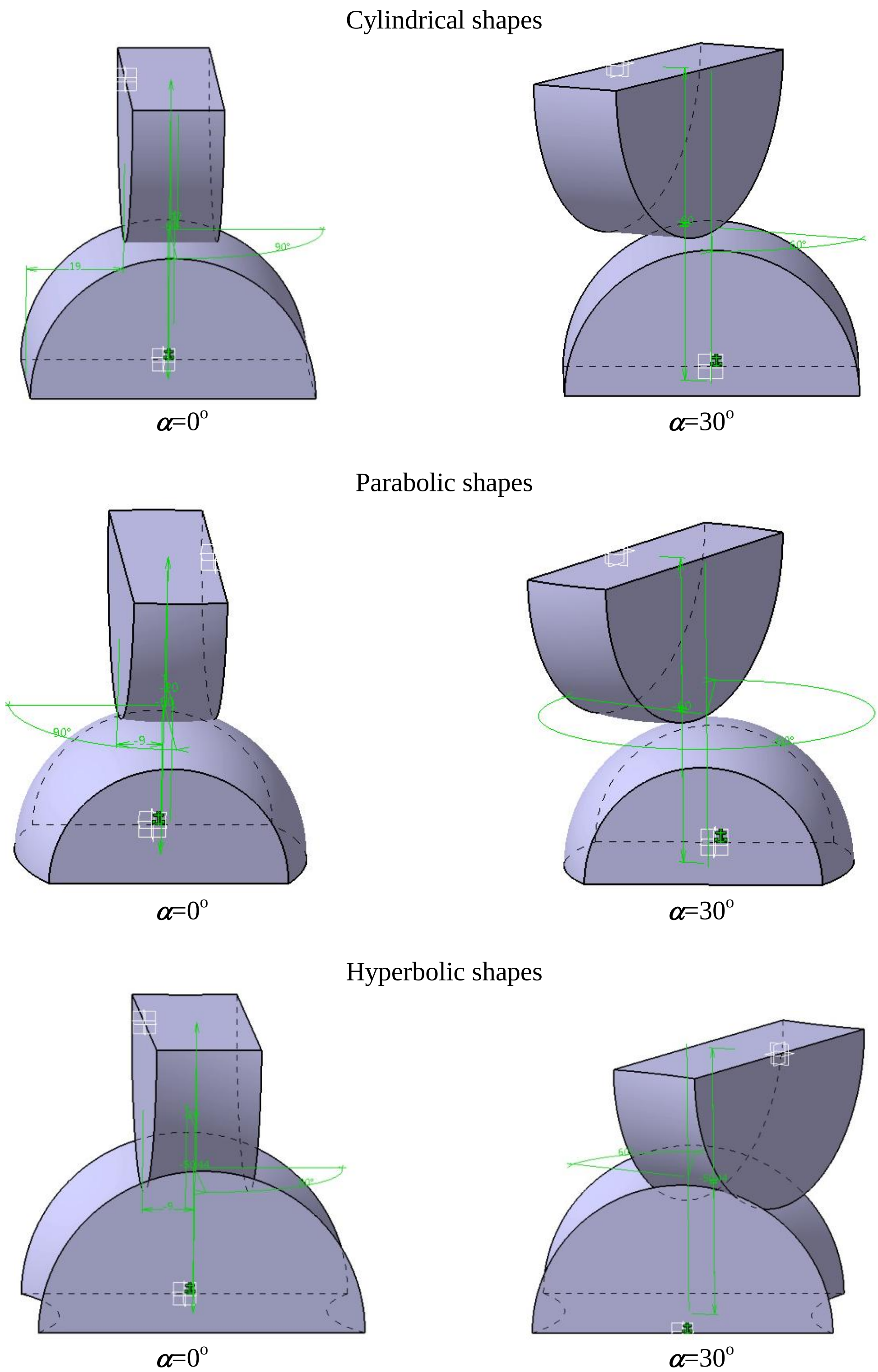

Figure 3. The geometrical model of the elements being in contact.

3. Results and conclusions

The results present the variation of the contact pressure of the elements being in contact, with the normal contact force and the angle between the input and the output shaft, for different shaped elements being in contact.

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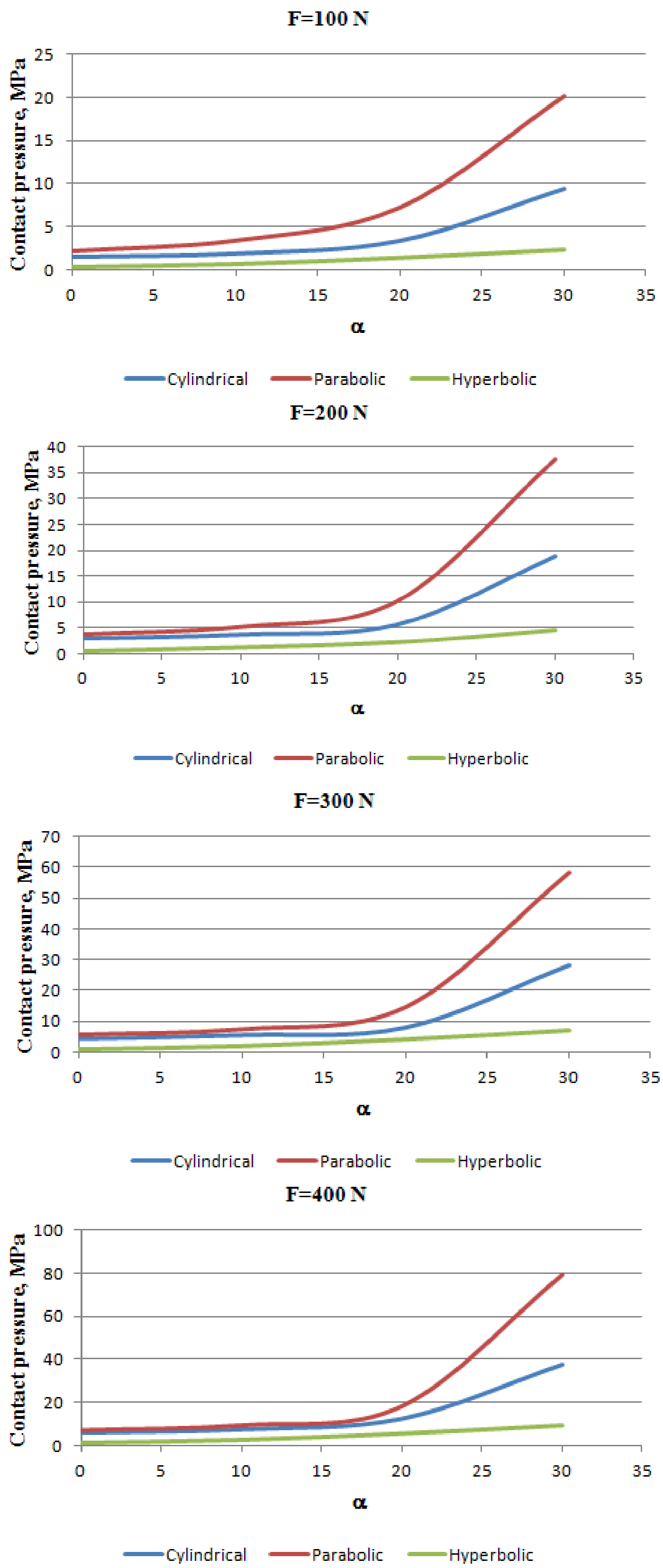

Figure 4. The variation of the contact pressure with the angle between the input and the output shaft.

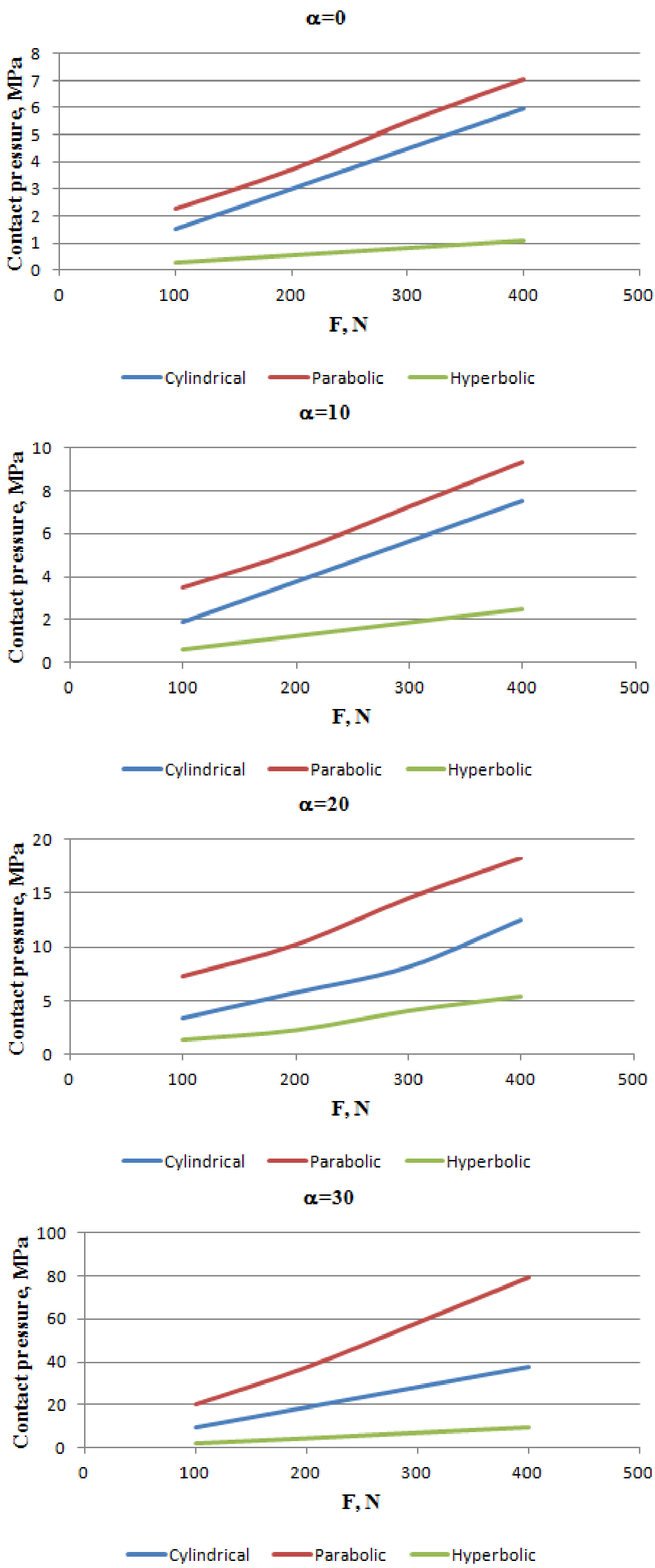

Figure 5. The variation of the contact pressure with the contact force.

Figure 4 presents the variation of the contact pressure with the angle between the input and the output shaft, for a set of values of the contact force. The value of the contact pressure increases with the increasing of the angle between the input and the output shaft. A roughly increasing is found out in the case of parabolic on parabolic type contact. Small values for the contact pressures are in the case of the hyperbolic on hyperbolic type contact which assures a higher loading capacity.

Figure 5 presents the variation of the contact pressure with the contact force, for different values of the angle between the input and the output shaft. The contact pressure has almost a linear increasing with the contact force; small values of the contact pressure are in the case of hyperbolic on hyperbolic type contacts.

In conclusion the hyperbolic on hyperbolic type contacts assure a higher loading capacity of the tripod coupling with external contacts due to the small values of the contact pressures.

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