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TRANSPORT TECHNICS. INVESTIGATION OF ELEMENTS. RELIABILITY

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VEHICLE ENGINES. APPLICATION OF FUELS TYPES. EFFICIENCY

Determining the forces for a plate – spring at a pull clutch on the supporting straps

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Abstract: *The development of vehicles and the expected higher demand those face-up requires lighter assemblies of the installation. The achievements in clutch design during recent years led to the so-called pull clutches. Their main features are higher compressive strength, lower shutdown power, cumulative design, calmer reception and torque transfer from the engine to other transmission. In this paper are shown the features of plate springs as a part of a pull clutch, the factors affecting the characteristics of plate-springs and the calculations of the forces for a clutch on the supporting straps. The results will show why that plate springs are increasingly used in motor vehicle clutches.*

Keywords: PULL CLUTCH, PLATE-SPRING, SUPPORTING STRAPS, FORCES.

Introduction

In the early 1980s, a clutch was expected to last about 50 000 km. It now typically last around 150 000 km, in many cases the working life of the car it was originally fitted in.

For severe service, the qualifications of a satisfactory friction-facing are density of structure, together with a reasonably high tensile-strength.

Also the coefficient of friction should be high and fairly constant over a wide range of temperature; the facing must be able to withstand high temperature without deterioration; the impregnating compound must not bleed out at high temperature; and the permeation of the impregnating solution must be complete so that the wear resistance is constant throughout the thickness of the facing.

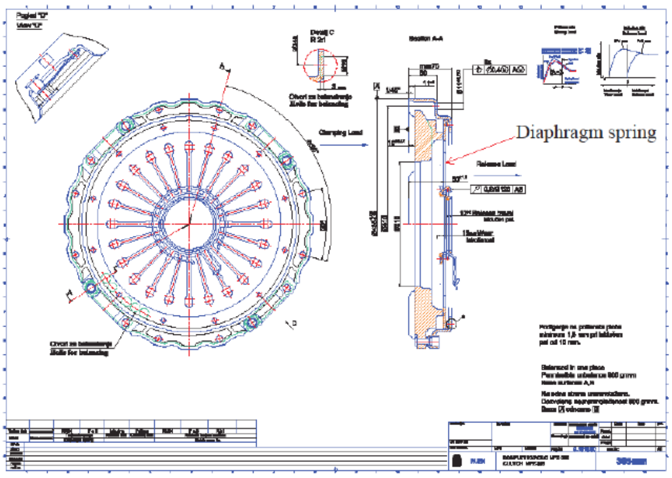

Fig. 1 *Pull – clutch*

1. General features of plate-springs

The main characteristic of plate-springs is to provide compressive force between the friction surfaces, which transmits the torque from the engine through the friction disk of the gear and other transmissions.

In addition to this task, plate-springs also provides:

- simple design of the cluch and simple constructive sollution,
- reduced number of elements, and thus reduced weight per unit of torque, also reducing the inertia.

Depending on the way the clutch disengagement force works, they are divided into push and pull clutches. **Push** or **pull** refers to the action to release the **clutch**. A **push clutch**, does just that, pushes on the disk cover or diaphragm, to release pressure on the disks, so the center is disengaged from the engine. A **pull clutch** pulls on the diaphragm to release pressure on the disks.

The development of vehicles and the expected higher demand those face-up requires lighter assemblies of the installation. It led to the so-called pull clutches (Figure 1). Their main features are higher compressive strength, lower shutdown power, cumulative design, calmer reception and torque transfer from the engine to other transmission.

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2. Geometric features of plate-springs

The geometrical characteristics of the plate-springs (PS) are shown in the drawing below (Figure 2) and it relates to the PS with a diameter of 362 mm designed for MHS 395 mm clutches (shown in Figure 1) for medium-haul vehicles with engine power between 250 - 300 kW.

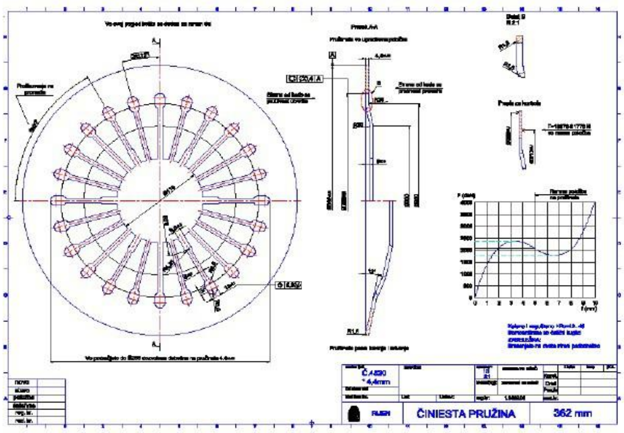

Fig. 2 *Plate-spring design*

3. Factors affecting the characteristics of plate-springs

The most important structural elements that affect dynamic spring strength are obesity, diameters, angle and spring support points, as well as dynamic and static strains. Each of these values directly or indirectly affects its voltage state. By changing one of them and the other being unchanged (constant sizes), the individual impact of each on its dynamic durability is determined.

The thickness is generally a determining element of the compressive and depressive forces. The highest thickness at the largest developed clutch (430 mm pull type clutch) is 5.6 mm.

The most commonly used (even exclusively) material for making plate springs is C4830 (51CrV4) as the most suitable. The material should be non-metallic, with a clean surface and no carbon coating. One of the most important characteristics of plate springs is the rigidity that is determined by the ratio of outer diameter and thickness of the spring (Da/s).

According to the permissible material voltages and the specified **Da/s** ratio is introduced a new relationship between the height of spring at a flat pole and its thickness (h/s), on which the flow characteristic of the spring depends, that is to say, a linear or non-linear relative characteristic of the spring characteristic. The most important structural elements that affect dynamic spring strength are obesity, diameters, angle and spring support points, as well as dynamic and static strain checking.

4. Calculations for plate-spring 362 mm

To calculate the plate springs in "Ruen" is used the MathCAD software package, a program calculation based on DIN 2092 has been created.

Table 1. *Input parameters for calculation of 362 mm plate spring (PS)*

Parameters	Symbol	Value	Unit
Outer Diameter of PS	D_a	362	mm
Inner Diameter of PS	D_i	288	mm
Bending angle of PS	e	12	degree
Thickness of PS	s	4.4	mm
Modulus of elasticity	E	20600	daN/mm^2
Poisson number for stainless steel	m	0.3	/
Outer diameter of the clutch relief	D_{a1}	358	mm
Inner diameter of the clutch relief	D_{i1}	310	mm
Control point	δf	3	
Off road	l	10.0	mm
Diameter of disconnected liner	d	120	mm

This calculation is the starting point for analyzing the forces of the spring as a function of the constructive elements and factors. The following is a calculation of the ф 362 mm plate spring with the nominal values of the two most influential geometric features (thickness and angle of the plate spring).

After a few step of calculations, it is needed to calculate the forces of the clutch on the supporting straps, minimum and maximum forces (F_s, F_{smax}, F_{smin}). The calculation way and the diagram (Figure 3) of the results is shown bellow

$$Fs(h) = kz \cdot Ft(h) = 2.002 \cdot 10^3 \text{ daN}$$

$$Fs(\partial f) = kz \cdot Ft(h - \partial f) = 2.281 \cdot 10^3 \text{ daN}$$

$$Fsmax = kz \cdot Ftmax = 2.284 \cdot 10^3 \text{ daN}$$

$$Fsmin = kz \cdot Ftmin = 1.721 \cdot 10^3 \text{ daN}$$

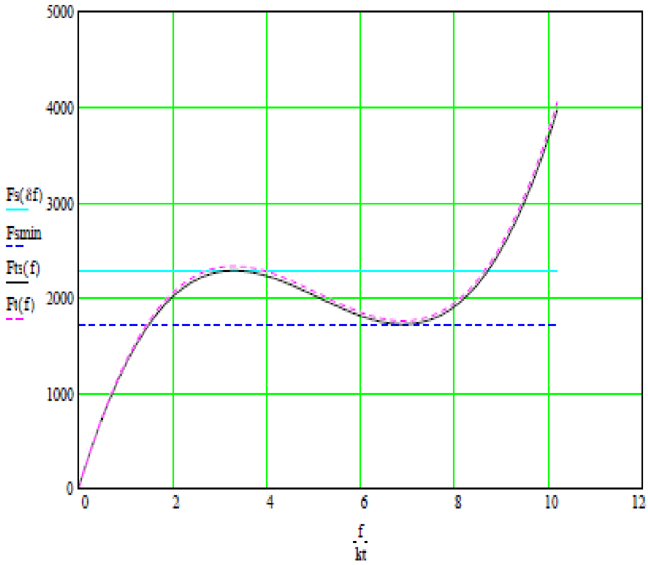

Fig. 3. *The diagram of forces of the clutch on the supporting straps*

At a ratio h/s> 1.5 the rigid characteristic of the plate springs is a degressive curve. This form is most applicable to plate springs for motor vehicle clutches. This ratio reduces the share of plastic deformation in the elastic deformation area, thus increasing the dynamic spring durability.

5. Conclusion

The wear of the friction disc laminates increases the compressive strength of the plate to a certain limit and then the force decreases, but not less than the compressive strength when there is no wear on the laminates, while at the torsion springs the laminate expands. Reducing the compressive force, and also the moment the clutch can transfer. This is one of the main reasons that plate springs are increasingly used in motor vehicle clutches.

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