

# Friction Phenomenon Study For the Chain Link – Pin Joint

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**Abstract.** The friction inside the automobile mechanical transmissions leads to a large influence of the classic fuel consumption and also to the environment impact. Actually, the chain drive is one of the most important transmission inside a car and has few friction sources inside, as the properly chain friction between its components (links, pins), the friction between the chain links and the sprockets and also the friction between the chain links and the tensioning guide active part. The paper main objective is to study the friction phenomenon in the chain link – pin contact for different loads. The tests are achieved for different sets of motion rotational speeds and normal loads; so according to these, there are determined the dynamic friction coefficient (during the motion) and the static friction coefficient (at the stroke ends). The results led to the static and dynamic friction coefficient variation, with the motion rotational speed and the normal loading force. In the final part, the conclusions are presented.

## 1. Introduction

The chain drive (with silent chains or bush chains inside) is one of the most important transmission inside a car and has, as disadvantages, few friction sources inside, as the properly chain friction between its components (links, pins), the friction between the chain links and the sprockets and also the friction between the chain links and the tensioning guide active part. The aim of the paper is to study the friction phenomenon in the chain link – pin contact for different considered loads.

Generally, the friction in a bush chain drive transmission can be split in the friction inside the chain links (between the links and pins or between the links and the bushes), the friction between the chain links and the sprockets and between the chain links and the tensioning guides [1, 2, 3].

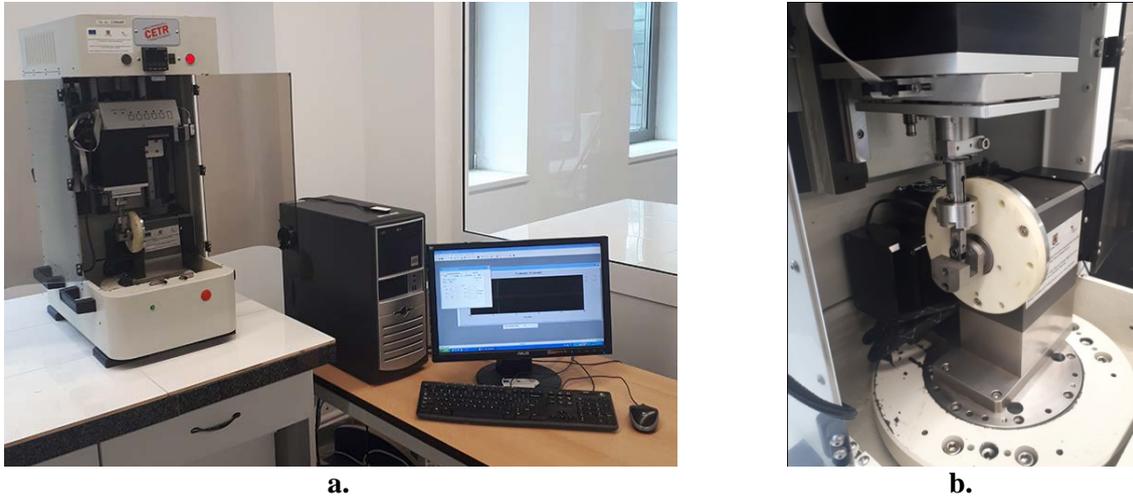
## 2. Experimental section

The tribometers are used to study the friction between two surfaces in contact [3, 4], which belong to real pieces adjusted to be a mechanical structure. The tribometer used for tests is equipped with a force sensor which allows the forces measurements along the vertical and also, a horizontal direction, in the interval of 0.1 to 1000 N, with the resolution of 50  $\mu$ N. The force sensor is placed on two sliders, for vertical motions, with a stroke up to 75 mm and a speed between 0.01 and 10 m/s. The lateral position resolution is  $R_r = 2 \mu$ m. The oscillatory motion module, allow the alternant rotational oscillating motion. To complete the testing and acquisition data system, the tribometer is connected to an acquisition plate, to a computer, as is presented in Figure 1, a.

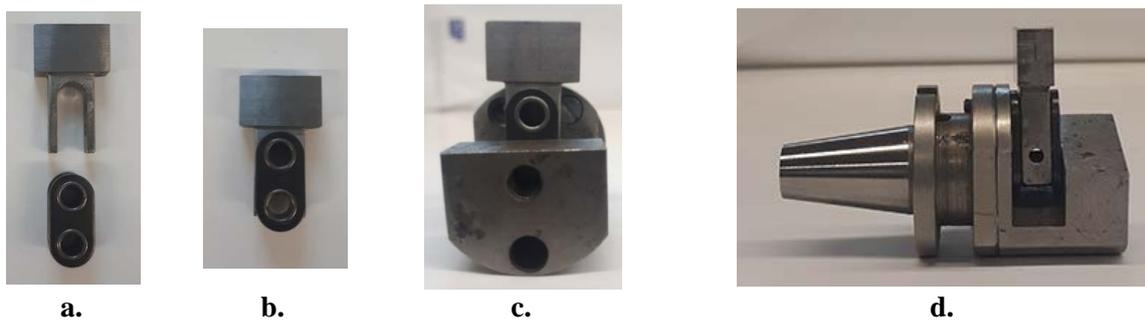
For testing various pieces, the tribometer has its own devices, to fit the parts together, but, there are situations when the pieces to be tested are in particular shape, so is not possible to be fitted in the apparatus device without some cutting, trimming or polishing operations. Usually, for small pieces, as bolt or chain links, this could lead to the part destruction [5]. To avoid this, it was used an adequate



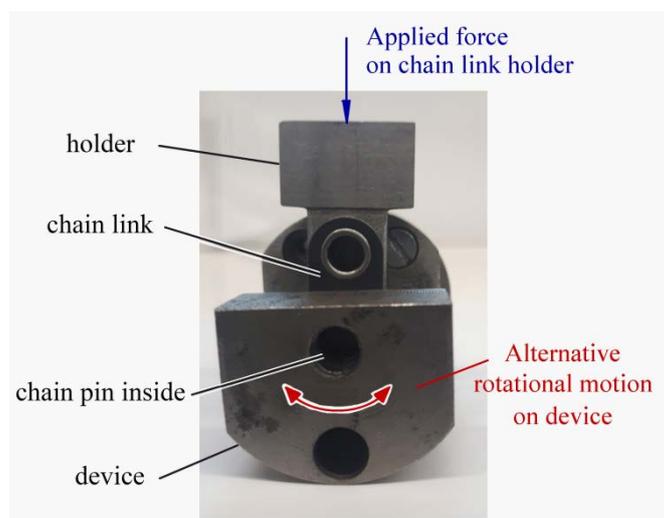
special device to keep small pin and chain links in relative motion, for the friction coefficient study in the chain link - pin joint. The device needs to fit in the tribometer adequate oscillatory motion module, as is presented in Figure 1, b.



**Figure 1.** The testing and data acquisition system.



**Figure 2.** The chain link in the adequate device.

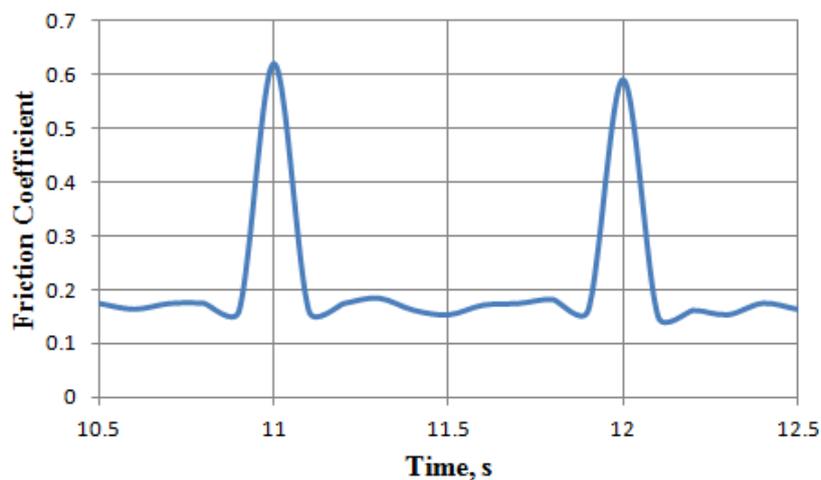


**Figure 3.** The load and the motion on device.

The pin is included by pressing in the special device and has to fit to the chain link, as in real functioning conditions of the chain joint [6, 7, 8]; then, the chain link is attached thru a special holder to the tribometer, as in presented in Figure 2. The detailed device ensemble with the applied force and motion is presented in Figure 3.

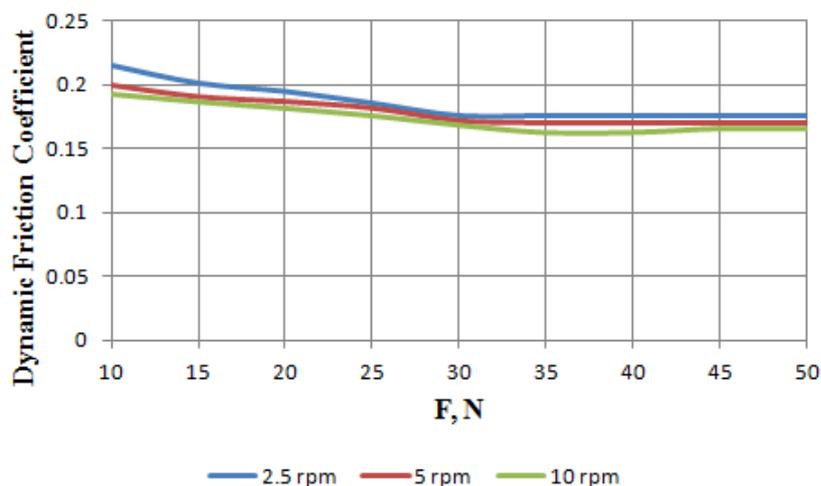
### 3. The tests and results

The tests are performed by using a chain link and a chain pin, fitted in the described device, without lubrication. The rotational motion is an alternative, in the interval of  $\pm 15$  degrees. There are chosen three sets of angular speeds as: 2.5 rpm, 5 rpm, 10 rpm, and each equivalent to  $15^\circ/s$ ,  $30^\circ/s$  and  $60^\circ/s$  respectively. The load normal force is variable between 10 to 50 N. As results, there are determined the dynamic friction coefficient, during the motion, and, respectively, the static friction coefficient, at the stroke ends.



**Figure 4.** The variation of the friction coefficient during the motion.

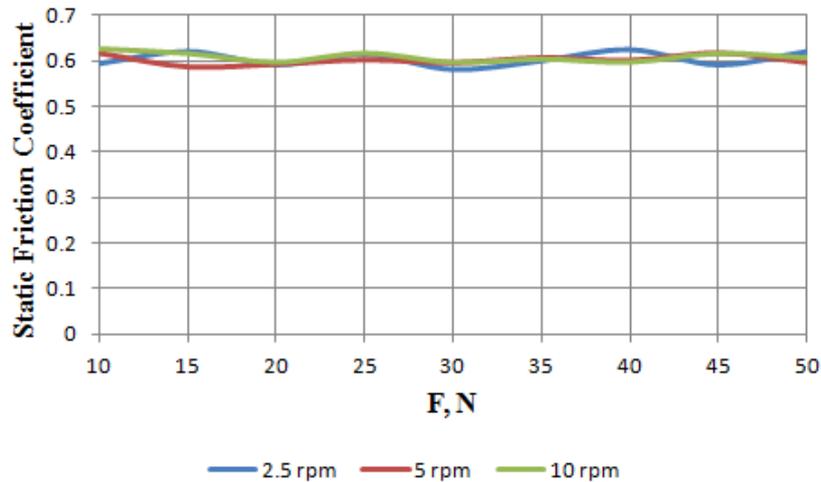
In Figure 4 is presented the variation of the friction coefficient during the motion. Along the corresponding motion portion of the curve, the dynamic friction coefficient can be observed. At the ends of the angular stroke, it can be observed the increased values of the static friction coefficient. The situation corresponds to the real chaining on the chain wheel, at the beginning of the relative rotation between the chain links and pins respectively.



**Figure 5.** The dynamic friction coefficient.

In Figure 5, the dynamic friction coefficient is presented, for different load force from 10 to 50 N and, respectively different rotation values. For decreased load force, the friction dynamic coefficient value is close to 0.2. For all the rotation speeds, at the load force increasing, the dynamic friction coefficient value is slightly decreasing around 0.17.

In Figure 6, the static friction coefficient is presented, for the same loads and rotation values. For different applied load force, the friction dynamic coefficient value is around 0.6.



**Figure 6.** The static friction coefficient.

#### 4. Conclusions

From the variation of the friction coefficient during the motion, it can be observed the increased values of the static friction coefficient at the ends of the angular stroke, which corresponds to the beginning of the links chaining on the chain wheel.

For studied case, the static friction coefficient value, in the mentioned testing inputs, is around 0.6 and the dynamic friction coefficient value is close to 0.2. For all the rotation speeds, at the load force increasing, the dynamic friction coefficient value is slightly decreasing around 0.17, which can be explained by the tested chain link - pin adjustment behaviour under the load.

Following the previously results, it can be concluded that the existing misalignments and clearances are influencing the chain link – pin joint friction condition. The chain adequate use and lubrication can improve the chain link – pin joint behaviour under load, in order to reduce the chain wear.

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