CORROSION AND SURFACE PROTECTION IN MACHINE MATERIALS FRICTION HAVE DIFFERENT SURFACE PAIRS EXPERIMENTAL INVESTIGATION OF FACTORS

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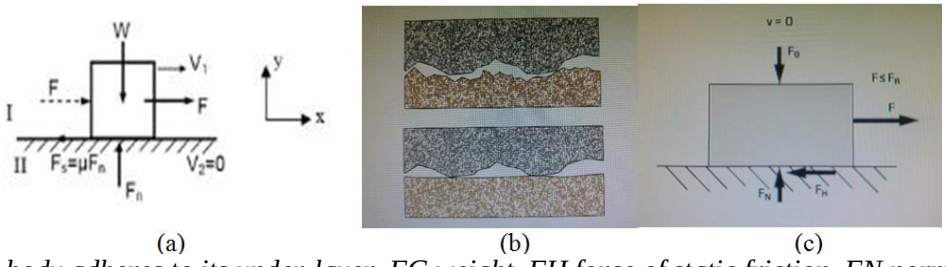
Abstract: *Friction force, normal force, linear change. The normal force varies with the loads on the friction object. In order to determine the friction force and the friction coefficient, the friction object and the friction speed are used. The experimental work was carried out in three stages. In the first stage, the effect of normal force on the friction force was studied. In the second step, the friction force of the friction surface area is influenced. The effect of the change of the shear rate in step 3 on the friction force was investigated. At the last stage, the experimental study of the effect of the material selection on the friction force was made and it was seen that the aluminum / brass surface pair had the smallest friction coefficient as a result of the opening. The greatest coefficient of friction is found in the pair of glass / felt objects.*

Key words: Friction coefficient, friction force, linear change, object surface pair

1. Introduction

While in statics, we study idealized bodies excluding frictional forces, in the study of static and kinetic friction, we investigate realsolid bodies. Friction occurs in all solid bodies that are in contact and that are moved against each other. The cause of the occurringforces is, among other things, the surface roughness, which causes the surfaces to interlock.[1].Friction is defined as the resistance they exhibit against two materials movements that are in contact with each other and tend to make or move relative to each other. There is a counter force against the force which wants to bring the relative movement between the two bodies, which is defined as the friction force, which prevents movement between the contact surfaces of the bodies[2].If there is no relative movement between surfaces touching each other, static friction is mentioned. If the relative motion exists between the surfaces of two bodies, the friction in this case is called dynamic or kinetic friction. Friction force is not constant. The friction force depends on the coefficient of friction and the friction force changes with the change of this coefficient. Relative movement of objects moving relative to each other, in the sense that no lubricant is placed between the surfaces;



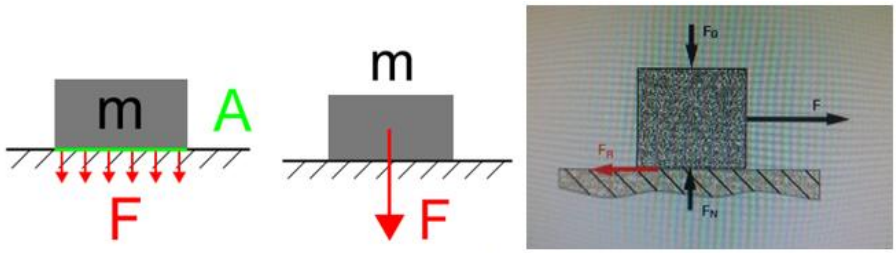
(a) (b) (c)

Fig. 1.*The body adheres to its under-layer, FG weight, FH force of static friction, FN normal force,F external force, v velocity*

Dry friction, liquid friction, and boundary friction between these two types of friction are investigated in three cases [3]. Static friction is present if displacing forces are actingon both bodies, but the bodies have not started to moverelative to each other yet. This is why we also talk aboutstatic friction that has to be overcome if we want to movea body. Static friction is a reaction force; in staticallydeterminate systems, it can be determined from theequilibrium conditions. (Figure 3 (c).)[3].
Dynamic friction occurs when a body moves along anotherand in contact with it, i.e. itactually rubs against it. Dynamicfriction increases with the roughnesses of the bodies' sur-faces and the pressure applied between the bodies. Thedynamic friction force is a physical force (active force) andproportional to the normal force FN.[1].

2. Experimental procedure

Determination of friction coefficients with surface friction.When a object slides on another object, it applies a force parallel to the slip surface. This force is defined as the frictional force and reverses the relative motion of the objects [2]. The friction diagram of the friction system is shown in figure 1. Frictional force; Normal force, used material, depending on the surface properties of the material; the friction surface is not dependent on the surface area and the rate of materials shift.[4].



(a), (b), (c)

Fig. 2.*FH force of static friction, FN normal force,F external force, v velocity*

3. Materials used in the experiment

Felt, Plastic, Aluminum Plate, Brass plate, Glass plate, Wooden plate, Friction plate; Plastic, Glass and Aluminum
Felt-covered brass, Felt Coated - Plastic, Felt-covered other materials

The experimental setup
Small diameter cable winder, It was kept constant in all the experimental works and moved at the same speed. All experiments were carried out under the same conditions. The dry friction test setup is shown in Figure 2.

Fig. 3. *Dry friction test setup.*

4. The shape of the friction test system

The dry friction test system has a metal base and two guide beds (1) on it. The guide bearings are designed in accordance with the carrier (2). The arrangement includes a synchronous motor (12). This synchronous motor has a rotation speed of 10 rpm and rotates the cable winder (9). When the cable winder is connected to the other carrier and the motor is started, the cable is wound and therefore the carrier is moving. Two different cables, one 7.5 mm in diameter and the other 15 mm in diameter, can be used in order to allow the carrier to move at different speeds.

The cable is removed from the carrier by manually opening it from the cable reel. In the test unit, friction plates (3) placed on the carrier; Made of aluminum, glass or plastic material.There is also a felt surface on the back of the plastic friction plate.Friction bodies (4) are made of aluminum or brass material. There is a felt surface on one side of boddy made from brass material and each of the friction objects is 1 Newton weight.

In addition, there are 8 loads (5) each weighing 0, 5 N in the experimental setup. The friction force generated between the frictional object and the friction plate is measured by means of a dynamometer (6) when the motor is operated and the cable winder connected to the carrier attracts the carrier.

The dynamometer has a measurement range of 2 N and sensitivity of 0.05 N. A damping cylinder (7) was placed in the dynamometer to suppress vibration on the dynamometer [3].

Dry friction test method is shown in Figure 3.

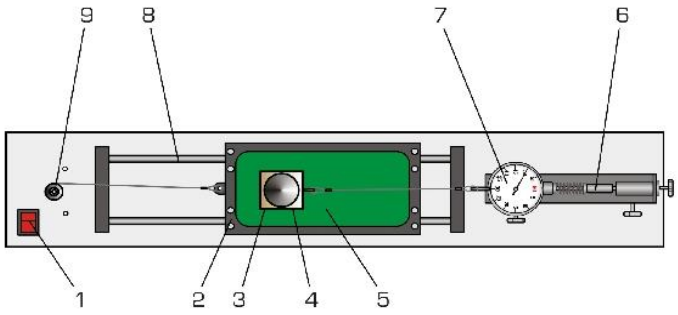


Fig. 4. *Schematic view of dry friction test setup.*

5. Effect of Normal Force on Frictional Force

Coulomb's law of friction states that the frictional force is proportional to the normal force. The proportionality factor μ depends on the materials pairing of the bodies and is called the coefficient of friction[1, 5].

$$FR = \mu \cdot FN \qquad (1)$$

Coulomb Law; Based on Coulomb's law, the friction force (FR), Normal force (Fn) shows a linear change. The normal force varies with the loads on the friction body. In order to determine the friction force and friction coefficient,

Friction plate: Felt

Friction body: Aluminum, smooth side (1 N)

Friction speed: Small diameter cable winder is used.

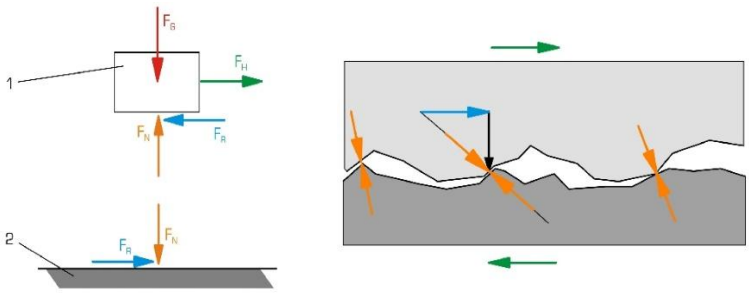


Fig. 5. *Schematic view of friction.*

Table 1. *Change of friction force due to normal force*

Fs [N]	0,1	0,24	0,36	0,5	0,62	0,74	0,86	0,99	1,2
Fn [N]	1,0	1,5	2,0	2,5	3,0	3,5	4,0	4,5	5,0
FR —	0,100	0,160	0,180	0,200	0,207	0,211	0,215	0,220	0,240

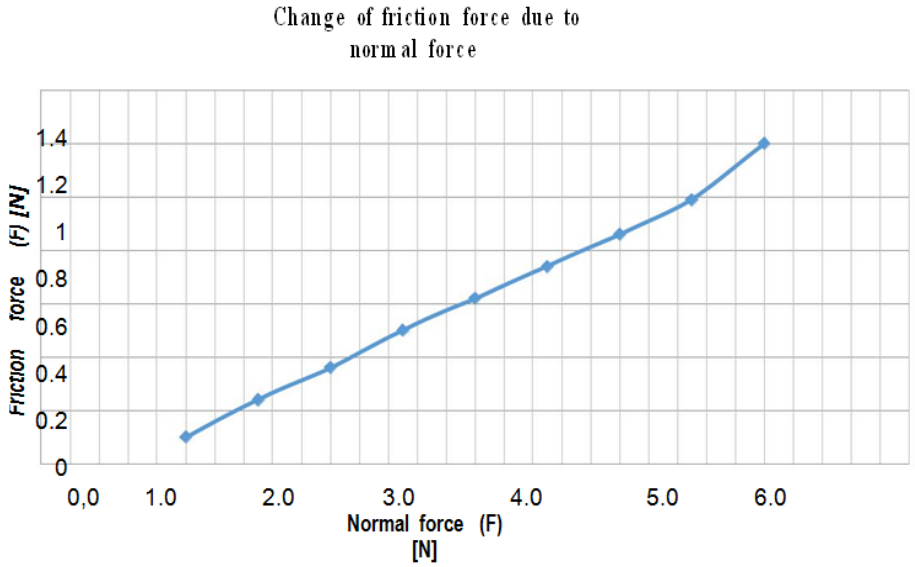


Fig. 6.*Normal force- dependent change of friction force*

According to the graph shown in Fig. 6, the curve showing a change in the normal force of the friction force shows a linear change.

When the normal force is equal to the subject weight, when we increase the weights added to the friction body, it is observed that the friction force also increases linearly.

6. Effect of Friction Surface Area on Frictional Force

In order to determine the effect of the surface area on the frictional force, the experiment is carried out by placing the surfaces of the frictional small object (Ak) and large (Ab) in the form of rectangular prisms on the friction plate.In order to determine the friction force and friction coefficient. In experimental setup; Aluminum plate; Ab-large surface, Ak-Small surface.

Friction plate: Aluminum

Friction body: Aluminum, small and large surface areas on the smooth side (1 N) Friction speed: Small diameter cable winder is used. Table 2 shows the measured values of the effect of the friction surface area on the friction force[5].

Table 2. *Measured values of the effect of the friction surface area on the friction force.*

Fs (Ak) [N]	0,17	0,26	0,30	0,42	0,54	0,57	0,65	0,70	0,81
Fs (Ab) [N]	0,43	0,53	0,67	0,78	0,99	1,18	1,29	1,42	1,79
Fn [N]	1,0	1,5	2,0	2,5	3,0	3,5	4,0	4,5	5,0
FR= —	0,170	0,173	0,150	0,168	0,180	0,163	0,163	0,156	0,162
FR= —	0,430	0,353	0,335	0,312	0,330	0,337	0,323	0,316	0,358

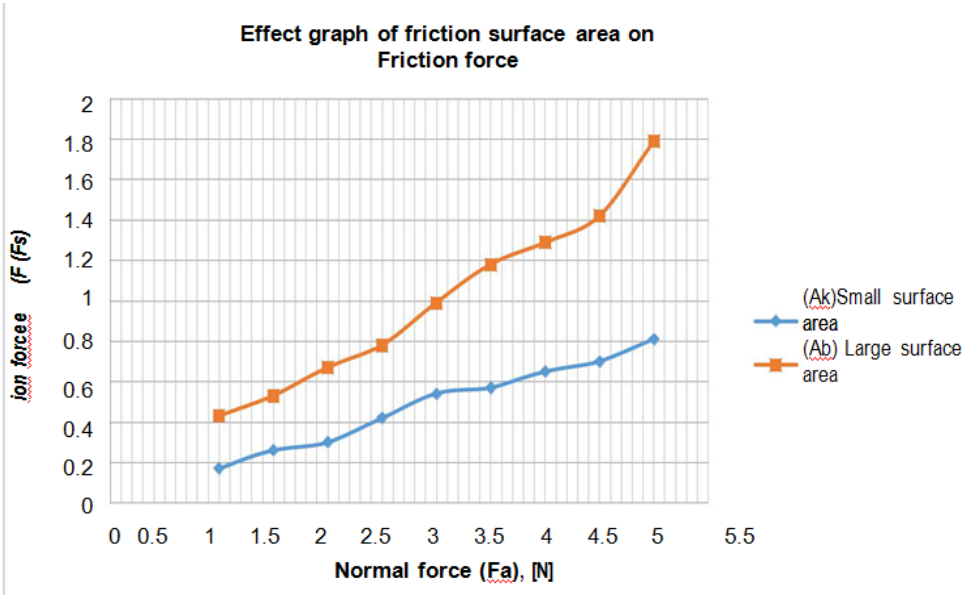


Fig. 7. *Effect graph of friction surface area on friction force. (Small surface area, large surface area).*

There is a linear relationship between the normal force (Fa) and the frictional force (Fs) according to the graph in Figure 7. As can be seen from this graph, the frictional force developed when the friction surface area increases is increased. But this contradicts the theory that the change in surface area does not affect the friction force. It is believed that the change in surface area can be caused by the friction force changing because large and small surface areas do not have the same surface qualities. As the area of the friction surface increases, the effect on friction increases.

7. Effect of change in shear rate on frictional force

In order to determine the effect of shear rate on the friction force, small diameter (dk), the experiment was carried out by using cable wrappers of the other large diameter (dB), and carrying the carrier at different speeds.In order to determine the friction force and friction coefficient,

Friction plate: Felt

Friction body: Aluminum, rough side (1 N)

Friction speed: Small and large diameter cable winders are used separately in each experiment.

Table 3. *Effect of change in shear rate on friction force*

Fs (dk) [N]	0,38	0,59	0,77	0,97	1,16	1,30
Fs (db) [N]	0,36	0,65	0,81	1,02	1,21	1,46
Fn [N]	1,0	1,5	2,0	2,5	3,0	3,5
FR= —	0,380	0,393	0,385	0,388	0,387	0,371
FR= —	0,390	0,433	0,405	0,408	0,403	0,417

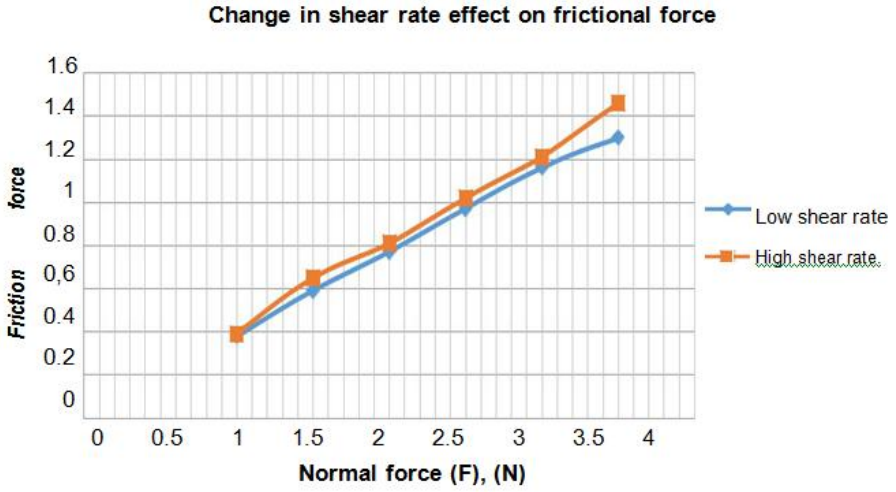


Fig. 8. *Change in shear rate effect on frictional force. (Low shear rate, High shear rate)*

8. Effect of surface properties on friction force

The rough and smooth side of the aluminum plate is placed on the friction plate to determine the effect of the surface properties on the friction force. In Table 1 and Table 3, the effects of aluminum friction on rough and smooth surfaces on friction were analyzed. In Table 1, the analysis of the smooth surface of aluminum showed that the friction force (Fs) at 3.5 N load was 0.74 N; the coefficient of friction (μ) was determined as 0.211. In the analysis made by placing the rough surface of aluminum in Table 3; Friction force (Fs) at 3.5 N load, 1, 46 N; the coefficient of friction (μ) was determined as 0,417. It is seen that the friction force and the friction coefficient on the rough surface are higher than the smooth surface.

9. Experimental investigation of effect of material selection on friction force

Experiments have been carried out by changing the friction plate and friction material to determine the effect of different materials on the friction force.

Determination of friction between aluminum / brass surface pair

In order to determine the friction force and friction coefficient,

Friction plate: Aluminum

Friction Body: Brass (1 N)

Friction speed: Small diameter cable winder is used.

Table 4. *Friction between aluminum / brass surface pair object (μ=Fs/Fn).*

Fs [N]	0,17	0,46	0,63	1,13	1,08	1,31
Fn [N]	1,0	2,0	2,5	3,0	4,0	5,0
μ= —	0,170	0,230	0,252	0,377	0,270	0,262

9.2. Determination of friction between glass / felt surface pair

In order to determine the friction force and friction coefficient,

Friction plate: Glass

Friction Body: Felt-covered brass (1 N)

Friction speed: Small diameter cable winder is used.

Table 5. *Friction between glass / felt surface pair(μ=Fs/Fn).*

Fs [N]	0,34	0,72	1,00	1,20	1,81	2,04
Fn [N]	1,0	2,0	2,5	3,0	4,0	5,0
μ= —	0,34	0,36	0,40	0,40	0,45	0,41

9.3. Determination of friction between plastic / felt surface pairs

In order to determine the friction force and friction coefficient,

Friction Plate: Plastic

Friction Body: Felt-coated surface (1 N)

Friction speed: Small diameter cable winder is used.

Table 6. *Friction between plastic / felt surface pair(μ=Fs/Fn).*

Fs [N]	0,29	0,74	0,90	1,12	1,43	1,65
Fn [N]	1,0	2,0	2,5	3,0	4,0	5,0
μ	0,29	0,37	0,36	0,37	0,36	0,33

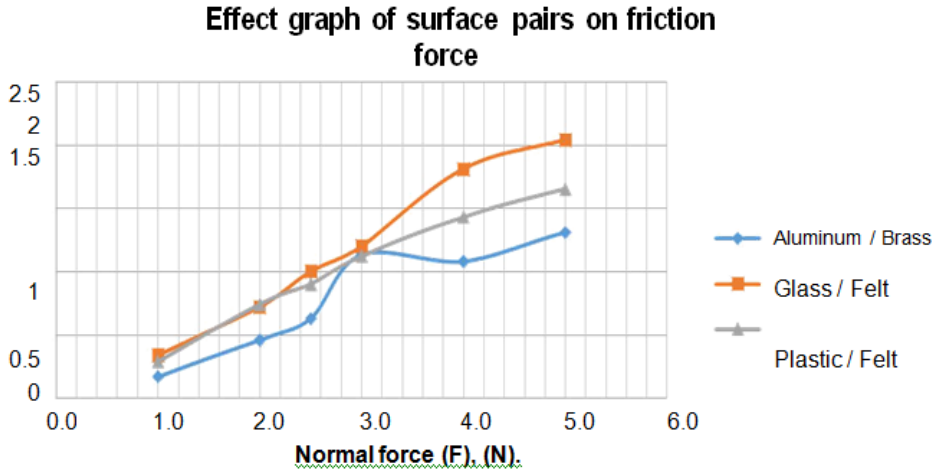


Fig. 9. *Effect graph of surface pairs on friction force*

10.Results

According to the graph in Figure 9, the greatest friction coefficients between the surface pairs are found in the glass and pad surface pair, and the smallest friction coefficients are found in the aluminum and brass surface pair.In the experiment, some measurement errors may occur during measurement of values. Depending on this fault, some deviations have occurred in the linear curve of the normal force-induced friction force. Experiments made with a pair of different materials showed that the glass / felt pair was the most abraded and the aluminum / brass material pair was exposed to the least friction and compressive force at the end of the period when the different materials started to act with friction and normal force at the beginning.

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