A NOTE ON SOME RESULTS OF FRICTION BETWEEN NON-METALS

By Shri H. P. Bhattacharyya, Defence Science Laboratory, Ministry of Defence, New Delhi

ABSTRACT

Some measurements on the coefficients of static friction of wood on wood, wood on rubber, wood on glass and of rubber on glass are described. In each case the coefficient of friction has been found to be independent of load (above 200 gms) thus suggesting for the friction mechanism to be on the similar lines of that of metals. The results of friction measurements show that the coefficient of friction depends to some extent on the nominal areas projected. For friction with rubber no dependence of coefficients of friction on load was observed. The coefficient of friction for wood sliding on rubber was observed smaller than that of rubber sliding on wood. Explanations for such interesting cases have been put forward.

Introduction

Experiments were undertaken to find out the coefficients of static friction for some particular non-metals like wood, rubber and glass with various combinations among themselves. Few such results are reported here. We have out of these used wood and rubber as sliders. It is hoped that data with glass used as a slider as well as that of the frictional behaviour of these non-metals with metals may be reported later on.

The importance of such investigations may be well understood from the fact that the coefficient of friction not only depends on the two surfaces concerned besides factors like load, surface conditions, as evidenced in some cases, but also on which of the two surfaces to be used as the slider. We have noticed, in fact, such variations of coefficient of friction in case of wood and rubber.

Experimental

The coefficients of friction have been measured by the conventional apparatus which has a fixed platform with a pulley attached to it, the frictional forces being measured from the weights hanging from this pulley. The friction between the pulley and the string connecting the loads with the slider and the friction of the pulley itself in its bearing have been neglected.

The coefficient of static friction was found out by the usual formula[2], $\mu = \frac{F}{W}$ where μ, F and W represent the coefficient of friction, frictional force (in the present case, load suspended from the pulley) and the total weight on the sliding surface respectively. F was noted at the point where the slider (upper surface) just begins to slide.

The results of the static friction of wood, rubber and glass in various combinations among these surfaces are shown in the tables below:—

The wooden surfaces were taken from blocks of approximate size (6″×3″×1½″) and the rubber and glass surfaces were available from sheets of approximate size (6″×3″×¾″) and (6″×3″×3/16″) respectively. Sliding operations were performed on both areas namely (6″×3″) and on (6″×1½″) to see whether the coefficient of friction depended on the nominal area.

TABLE I

Friction of wood on Rubber (wood sliding)

Sliding area (6″×3″)

Load (W) in gms	Frictional Force (F) in gms wt.	Coefficient of friction μ
625	422	0·675
725	508	0·700
825	621	0·752
925	648	0·700
1025	718	0·700
1125	801	0·712

TABLE Ia

Sliding area (6″ × 1½″)

Load (W) in gms	Frictional Force (F) in gms wt.	Coefficient of friction μ
625	554	0.886
725	661	0.911
825	720	0.872
925	834	0.902
1025	927	0.904
1125	1064	0.946

TABLE Ib

Friction of Rubber on Wood (Rubber sliding)

Sliding area (6″ × 3″)

Load (W) in gms	Frictional force (F) in gms	Coefficient of friction μ
207	240	1.160
307	330	1.075
407	444	1.091
507	571	1.127
607	671	1.103
707	801	1.133
807	918	1.137

TABLE II

Friction of	Sliding area	Mean coefficient of friction
Rubber on Rubber	6″ × 3″	1.118
Rubber on glass (rubber sliding)	6″ × 3″	1.235
Wood on wood	6″ × 3″	0.173
	6″ × 1½″	0.183
Wood on glass (wood sliding)	6″ × 3″	0.134
	6″ × 1½″	0.143

Discussion

As it is already known the data given here may not be quite reproducible because it is difficult to estimate the optimum value for the frictional force correctly though each reading was checked before it had been recorded finally. For very rough surface it was difficult to make the correct estimation of the frictional force as the change from standstill to sliding was abrupt, while, for smooth surfaces one could see the sliding gradually building up. Frictional measurements for smooth surfaces should therefore be much more reproducible than for rough surfaces. For substances which have low coefficients of friction this reproducibility is very much desirable. The samples of wood tested were carefully machined for this purpose. The friction of wood on wood or wood on glass is probably due largely to the mechanical friction in the surface asperities. Very low value of coefficient of friction and observed wood-dust give confirmation to this. It may be possible that wood may break before it can flow plastically. The coefficient of wood on wood was a bit higher than that of wood on glass. This is probably due to less mechanical interlocking with glass as this has a much more smoother surface than wood.

It was interesting to find that the coefficient of friction of wood sliding on rubber was different from that of rubber sliding on wood. The friction was greater when rubber was sliding. This discrepancy can be explained by the fact that more rubber went into plastic welds when rubber was taken as the upper surface. The friction of wood on rubber is possibly almost entirely due to shearing in the rubber welds though mechanical interlocking and ploughing of wood in rubber might be also considerable.

The coefficient of friction was found to depend on nominal area, though this dependence was low. In fact, this coefficient was observed to increase with the decrease of nominal area as expected. This may be due to the fact that for a particular load if the projected area be large, then the distribution of the load on true contact area may be such as to make the pressures at the points of contact lower than when the projected area would be smaller. This would lead to a higher friction on smaller nominal areas and the results also show this. However, this point needs further checking up and we hope to collect more data on this to discuss it in detail elsewhere.

Throughout the experiments the coefficient of friction was found to be independent of load, a fact that seems to be almost universal in friction. Even the friction of wood on wood or glass was no exception to this. Assuming that this friction was almost a pure case of mechanical friction our results will verify the theoretical deduction for the expression of the coefficient of static friction in such cases which is usually given by $\mu = \frac{h}{\lambda}$ where, μ is the coefficient of friction, h the average height of a hill and λ the average distance of asperities in the surface. Note that in th s expression μ is independent of load. That the friction of rubber also was found to be independent of load is possibly due to the effect of high loads.

ACKNOWLEDGEMENT

The author is indebted to Prof. D. S. Kothari, Scientific Adviser, Ministry of Defence, Government of India, for his constant encouragement during the work.

REFERENCES

1. Frictional Phenomena Gemant, (Chemical Publishing), 1950.

2. The Friction and Lubrication of Solids, Bowden and Tabor, (Oxford), 1950.