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THE INFLUENCE OF ULTRASONIC VIBRATION ON THE COEFFICIENT OF FRICTION BY USE OF THE SEMI-CIRCULAR RING

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THE INFLUENCE OF ULTRASONIC VIBRATION ON THE COEFFICIENT OF FRICTION BY USE OF THE SEMI-CIRCULAR RING

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ABSTRACT

The author investigated the snapping action of the semi-circular ring clamped at both ends and compressed symmetrically by a plane, as shown in Fig. 1, and evaluated from the experimental results the coefficient of the friction between the ring and the plane and also evaluated the decrement of the coefficient by the ultrasonic vibration of the plane.

1. Principle

For the non-dimensional load of $PR^2/EI \leq 2.696$, where P, 2R and EI stand respectively for the load along the axis of symmetry, the mean diameter of the ring, and the bending rigidity, the plane touches the ring tangentially as shown in



Fig. 1-a. Arrangement of the ring.



Fig. 1-b. Contact of the plane with the ring at the load $PR^2/EI < 2.696$





Fig. 1-c. Contact of the plane with the ring at the critical load.



Fig. 1-b. If the load is $PR^2/EI>2.696$ but smaller than the critical load, the ring will touch the plane only in part and the rest will be curved. When the load exceeds the critical load, the straightened portion of the ring will sink down, will snap, as seen in Fig. 1-d. At the critical state as shown in Fig. 1-c, the straightened portion of the ring is just before the snapping and the ring will touch both ends of the straightened portion. The force acting at the ends is composed by the vertical loads (P/2) and the frictional forces $(P/2) \times \mu_s = (P/2) \times \tan \alpha_{cr}$, and the resultant forces are $(P/2) \times \sec \alpha_{cr}$ as shown in Fig. 1-c. The tan α_{cr} is equal to the critical coefficient of the static friction μ_s .

By taking α_{cr} as a parameter and applying the theory of "undulating elastica" to the curved parts of the ring, the relations between the vertical deflection V and the horizontal deflection H were caluculated and are given in Fig. 2, using the method developed by FRISH-FAY (1962).



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2. Experimental Method and Results

Fig. 3 shows the arrangement of the experimental apparatus, which consists of a universal testing machine, an ultrasonic transducer and a jig fixed at the





Fig. 3. Arrangement of the experimental apparatus.

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cross head of the machine. Flat spring materials of hardened steel were used for the semi-circular rings, while the specimens for the plans were of 0.45% carbon steel and of aluminium.

Some of the results of the experiment are shown in Fig. 4.

The photographs of before and after critical state are shown as follows.







It was confirmed that the coefficient of friction gradually decreased with the ultrasonic vibration of the plane. In the cases of steel and aluminium specimen, for example, an analysis of Fig. 2 and Fig. 4 shows the existence of the relations as follows.

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Conditions of Experiments	Materials of Plane	Values of μ_s
<u></u>	Steel	0.65
Static	Aluminum	0.78
	Steel	0.58
with Oltrasonic, \perp cal	Aluminum	0.45
	Steel	0.40
with Offrasonic, // ef	Aluminum	0.40

Table of Experimental Results

3. Discussion

Since the above values are extremely sensitive to the conditions of the experiment, further study on the subject is expected to increase the accuracy of evaluation. But the values of μ_s in the above Experimental Results Table are agreeable to the data given by RUIZ and KOENIGSBERGER (1970).

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